REPORT RESUMES

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INSTRUCTION IN FARM MECHANICS, SUGGESTIONS FOR DEVELOPING TRAINING PROGRAMS IN FARM MECHANICS IN VOCATIONAL AGRICULTURE.

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DESCRIPTORS- *AGRICULTURAL ENGINEERING, *VOCATIONAL AGRICULTURE, *PROGRAM DEVELOPMENT, *TEACHING GUIDES,

THE PURPOSE OF THE PROGRAM GUIDE IS TO ASSIST TEACHERS IN TRAINING YOUNG FARMERS AND FARM WORKERS IN THE SELECTION, OPERATION, UTILIZATION, AND MAINTENANCE OF FARM TOOLS, MACHINERY, AND MECHANICAL EQUIPMENT. DESIGNED BY NATIONAL AGRICULTURAL EDUCATION SPECIALISTS, THE DOCUMENT INCLUDES CHAPTERS ON THE CHANGING FARM, SETTING UP PROGRAMS, FARM MECHANICS OBJECTIVES AND PROCEDURES, FARM POWER AND MACHINERY, SOIL AND WATER MANAGEMENT, FARM BUILDINGS AND CONVENIENCES, FARM ELECTRIFICATION, AND FARM SHOP WORK. DISCUSSION TOPICS ARE INCLUDED AT INTERVALS THROUGHOUT THE DOCUMENT. A GLOSSARY OF COMMON TERMS IS INCLUDED. THIS DOCUMENT IS AVAILABLE AS GPO NUMBER FS 5.281--81009 FOR 50 CENTS FROM SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. 20402. (JM)

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INSTRUCTION in FARM MECHANICS

Suggestions for Developing Training Programs in Farm Mechanics in Vocational Agriculture

by

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Foreword

VOCATIONAL EDUCATION in agriculture has for half a century been a major force in the educational life of America; but, as we face the recent shift of families from rural areas to urban centers, together with new technological developments, it becomes essential to revamp programs to keep them in step with the changing educational structure.

The decline in the number of small farms and increase in output from multiple farming enterprises have made farming, to a great extent, a mechanical-electrical industry. There is almost total dependence on power farming—both motor and electric—to make each farm unit more productive. Much of the power equipment is farmer-owned, but some is owned by cooperatives and private farm service businesses, and often is operated by skilled hired hands. In some cases, due to capital requirements, there is an increasing amount of equipment leased or rented for special jobs, and some jobs are being contracted out, such as terracing, land leveling, ditching, plowing, spraying pesticide and herbicide chemicals, feed processing, and harvesting.

This publication is prepared primarily for teachers of Vocational Agriculture, and is designed to assist them in the training of young farmers and farm workers in the selection, operation, proper use, and maintenance of farm tools, machinery, and mechanical equipment. There is a continuing need to keep farmers advised of new types of equipment and for training in the use and maintenance of this equipment.

WALTER M. ARNOLD
Assistant Commissioner of
Vocational and Technical Education

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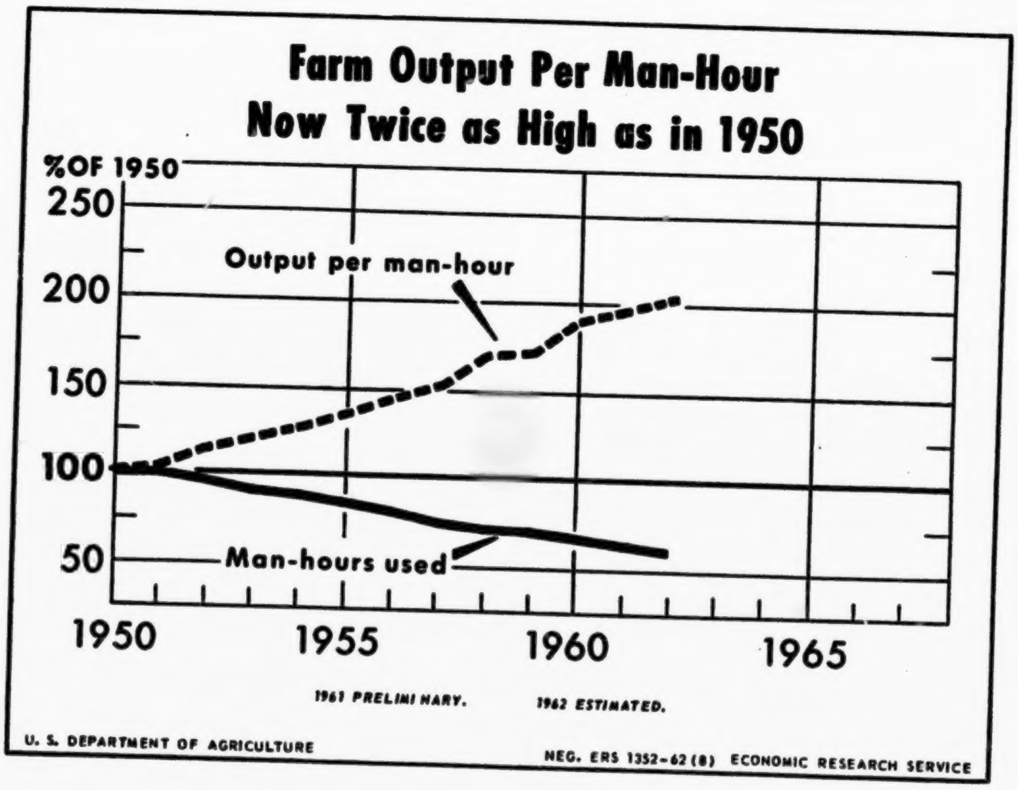
Chapter I. The Changing American Farm

IN COLONIAL DAYS 85 percent of our people gained their living from working the soil. Today, with the per capita consumption of farm products much higher, the rural farm population of 7.5 percent produce an abundance of many food and fiber items.This increased productivity per farm worker is a result of improved agricultural technology, including mechanization on the larger farms. Today agriculture is big business. During World War I each farm worker had an average of 5 horsepower at his command, while at present it approaches 50 horsepower. During this same period the pro-



1961 PRELIMINARY. 1962 ESTIMATED.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 1352-62 (8) ECONOMIC RESEARCH SERVICE

Figure 1.—Productivity per man hour on the farm continues to increase.

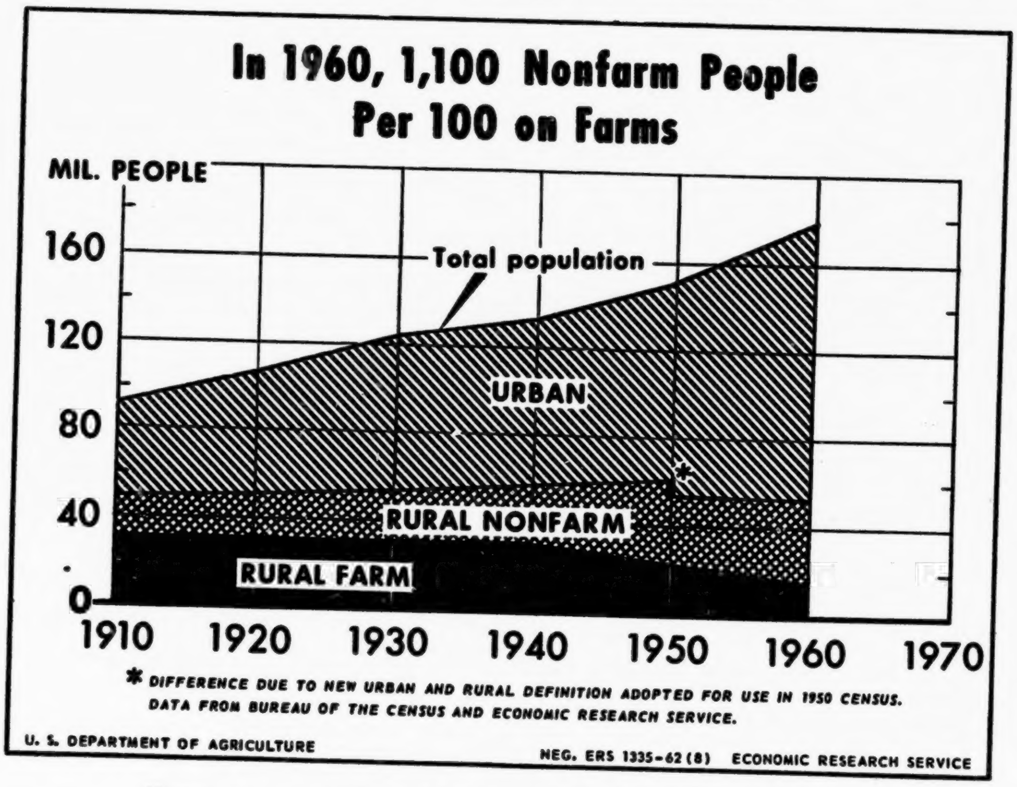


Figure 2.—The percent of farm population continues to decline.

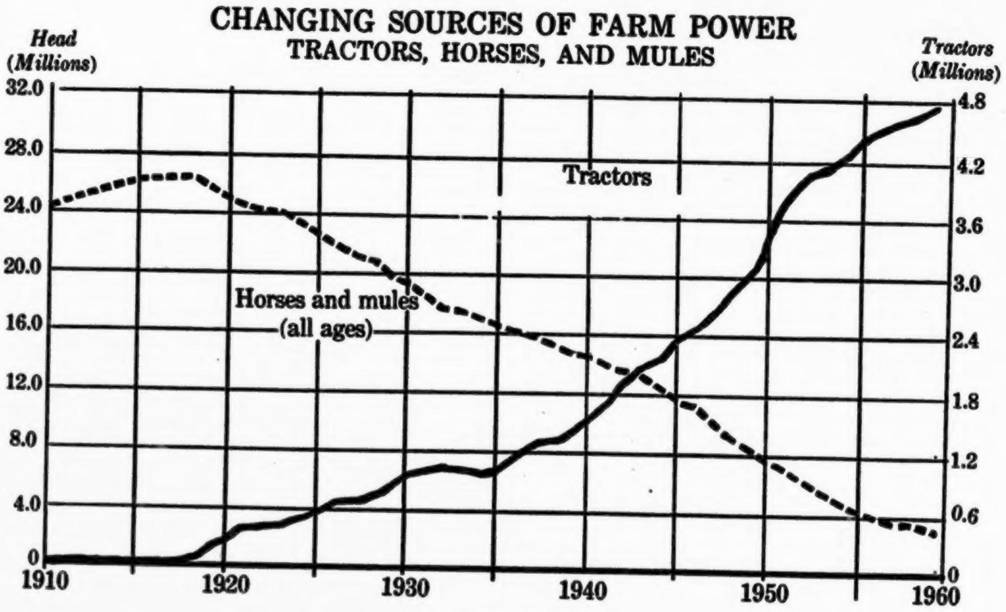


Figure 3.—The farm tractor continues to replace animal power.

ductivity per worker has more than quadrupled and now an average farm worker provides food and fiber for 27 persons.

Today, with fewer farmers on the land, there is a compensating increase of workers employed in agricultural occupations, other than in farming. The farm boy, with his experience of rural life and work on the farm, has a distinct advantage for gainful employment in the broad field of agriculture. Unlimited opportunities exist in most localities for agriculturists to serve as custom operators who apply lime, insecticides, pesticides, fumigants, and fertilizers; processors of dairy products, animal feeds, and meats; constructors of irrigation ditches, drainage ditches, terraces, and farm reservoirs; and assistants in the marketing, transportation, and distribution of farm produce. Other jobs would include gardening and landscaping to meet the needs of home owners, business firms, and highway departments. Nearly all of these agricultural occupations require evidenced experience in one or more areas of farm mechanics.

In the next decade those who operate the land will have a greater dependence on power farming—both motor and electric. Much of the power equipment will be farmer-owned and may be operated by him or by hired operators. There will be a continuing need for an adequate program to train high school farm youth, young farmers, and adult farmers in the selection, operation, proper use, and maintenance of farm tools, machinery, and other mechanical equipment. There will be a continuing need to keep farmers advised of new types of farm machines and equipment and for training in their use. In some cases equipment will be rented for special jobs and some jobs will be contracted. Types of jobs that may be contracted are terracing, land leveling, ditching, dam construction, sewage system installation, logging, rock removal, tiling, plowing, spraying pesticide and herbicide chemicals, processing, and harvesting.

Until World War II the mechanical instruction in vocational agriculture was mainly in the area of farm shop work. Today the program has been expanded to meet the needs of mechanized agriculture. Training involves five areas—farm power and machinery, soil and water management, farm buildings and conveniences, farm electrification, and farm shop work.

Farm Power and Machinery

There has been more progress in farm mechanization during the past 30 years than during the previous recorded history. Farm mechanization is responsible for many new and improved practices, as illustrated by the following facts:

Figure 4. The combine makes possible a rapid harvest to lessen field losses.

The last United States census report shows a production of 3,697,190,984 bushels of corn. A man husking corn by hand in a field yielding 100 bushels per acre would do well to husk 100 bushels per day. It would require approximately 474,000 men working at the same rate throughout the months of October, November, and December to harvest the Nation's corn crop. The task of hand harvesting has been practically replaced by the easier and faster mechanical method. The 1960 census reports 792,379 mechanical corn pickers on our farms.

The history of the combine harvester-thresher follows closely the development of other modern farm machines of major importance. The combine, having many adjustments and several attachments, can cut and thresh almost any grain crop. The 1960 census reports 1,041,553 combines in the United States.

The same census reports the number of pickup balers on farms in the United States has increased from 25,135 in 1942 to 679,776. With the increased mechanization of the farm, it is not unusual for a farmer to have as much invested in farm power, machinery, and equipment as in the land. On well-managed farms, machinery is not merely a self-gratifying exhibit, but a practical production tool that must pay its own way. In order to select field machinery efficiently, one must consider implement performance, power availability, trained labor, timeliness, and costs to obtain optimum economic re-

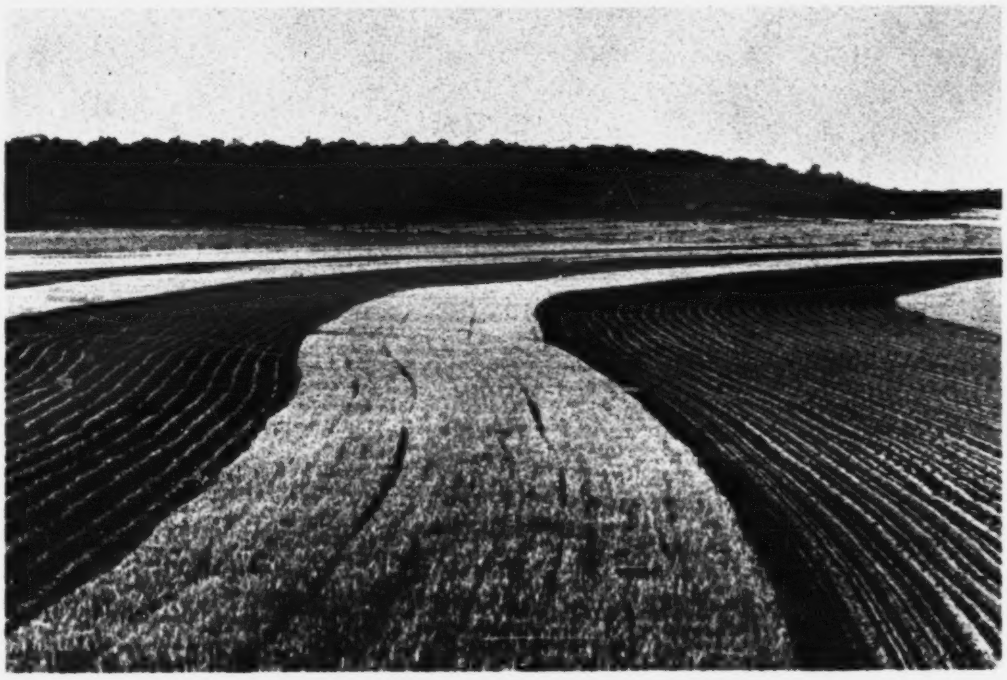


Figure 5.—Strip cropping as a part of a sound wind and water erosion control program.

turns. A generally accepted principle is that farm mechanization is only as successful as the maintenance given to it.

Soil and Water Management

Irrigation practices are expanding rapidly and are now used in all sections of the United States. Power farming has made possible the installation of approved drainage practices to reclaim much land as a part of modern farming. Progress is being made to further control wind and water erosion, and to develop water storage for livestock, crops, and recreation. Strip cropping, terracing, and the practice of contouring is expanding each year as a part of a sound conservation program.

Farm Buildings and Conveniences

Since farming has changed in its mechanical phases from animal power to mechanical power, many farm buildings are now obsolete. These farm buildings are often reconstructed to make them functional for mechanized agriculture. New ones are also being constructed to meet the needs of modern agriculture. These redesigned and new farm structures are

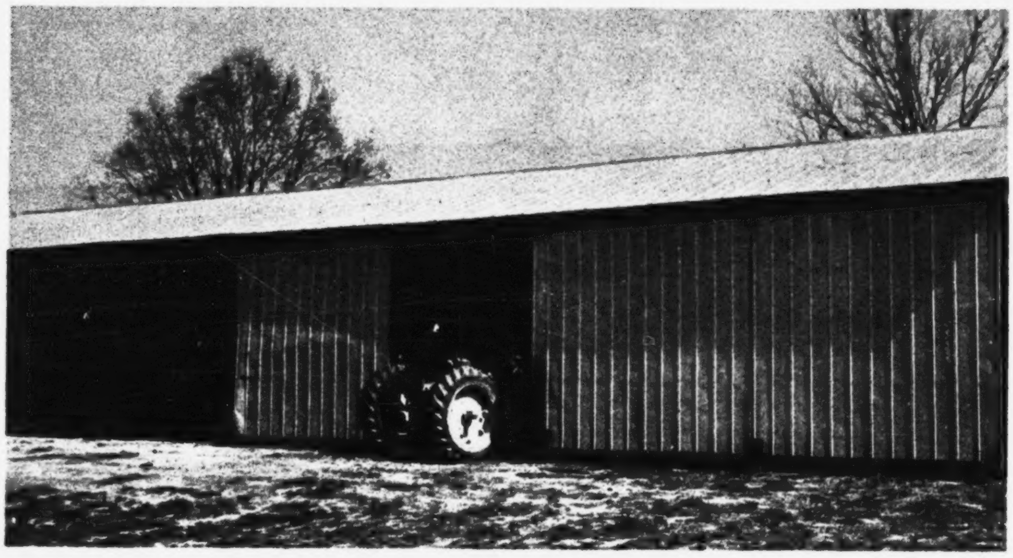


Figure 6.—Farm buildings are often constructed or reconstructed to meet the specific needs of a mechanical age.

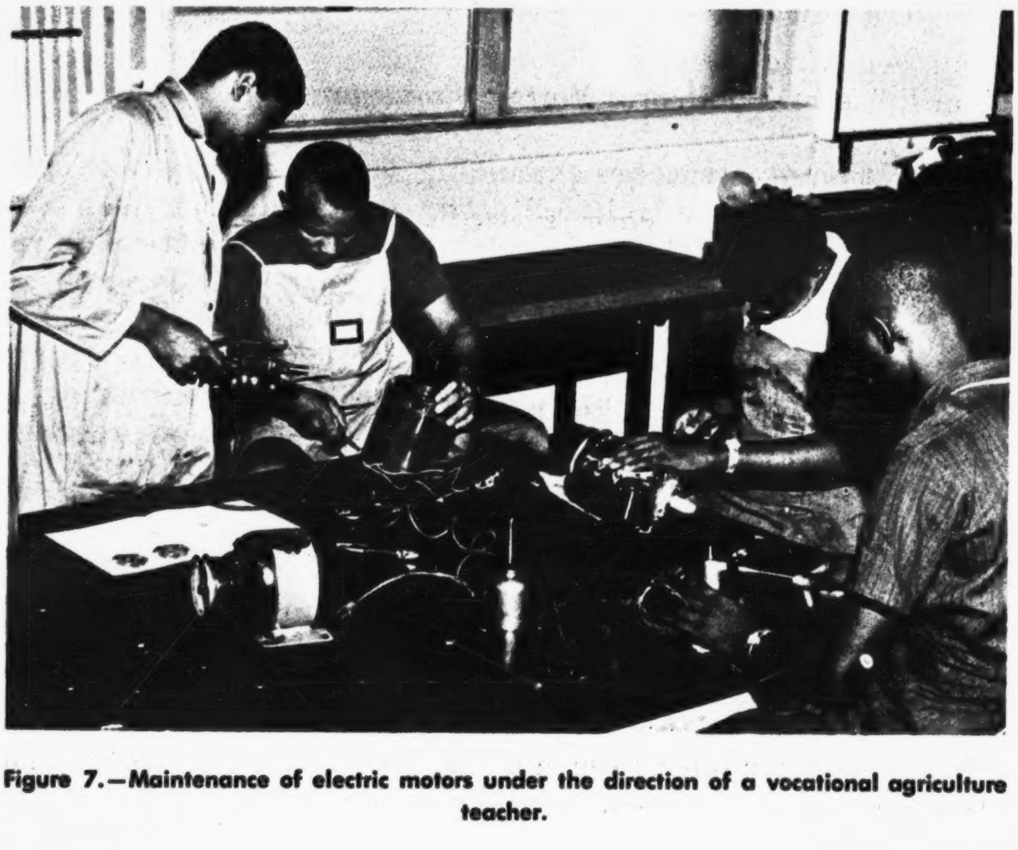


Figure 7.—Maintenance of electric motors under the direction of a vocational agriculture teacher.

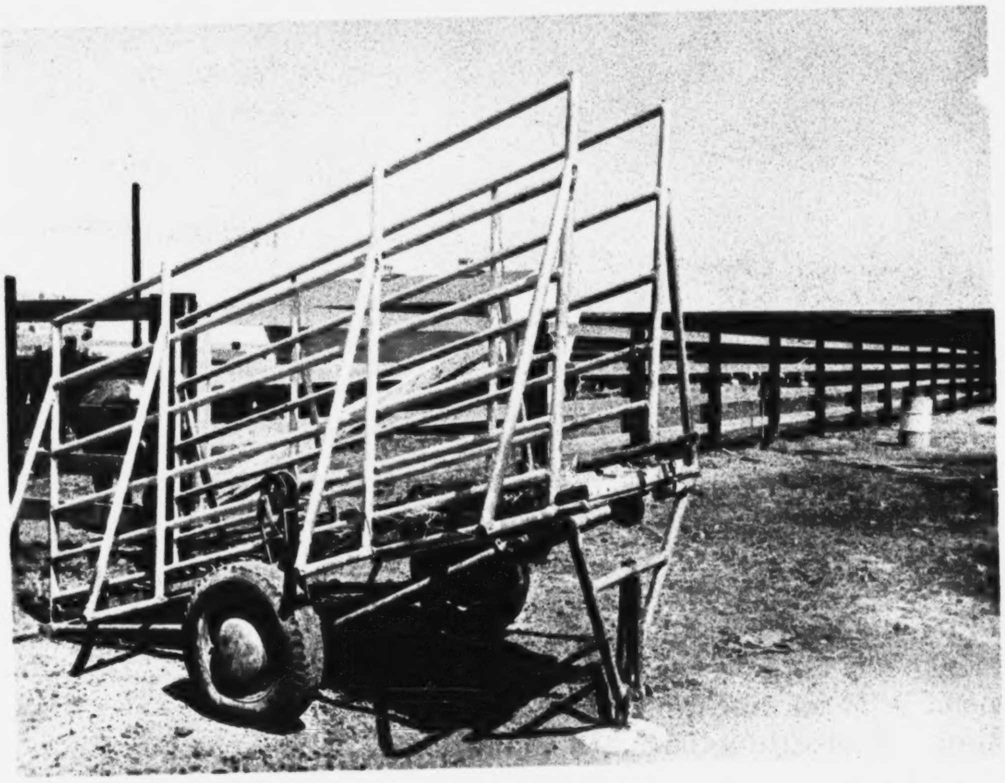


Figure 8.—A portable loading chute constructed in the school farm shop by a student of vocational agriculture.

equipped with many conveniences, such as elevators, hay and grain driers, conveyors, running water, and mixers for feeds and fertilizers.

Farm Electrification

Electric power lines have been extended to make electricity available to more than 99 percent of the Nation's farms. A multitude of practical uses have been developed for this power, both in the home and on the farm. Electric power is a necessity to farmers rather than a luxury.

Farm Shop Work

Agriculture was taught in some schools prior to the passage of the Smith-Hughes Act in 1917. At that time a few high schools also taught farm mechanics. In the early days farm mechanics instruction was mostly farm shop work. Today, the farm mechanics program has been expanded to include the five areas discussed in this chapter.

Chapter II. Setting Up the Program

INSTRUCTION in farm mechanics is given in more than 10,000 departments of vocational agriculture in the United States. Approximately 9,000 departments have farm mechanics shops, most of which are adequate in size and design and are well equipped. Much progress is being made in improving farm mechanics by including instruction in the five areas discussed in Chapter I. Training is provided on a practical basis to meet the needs of modern farmers. This training need in farm mechanics is determined by the teacher of vocational agriculture through home visits to the students when supervising the farming programs being developed.

Farm mechanics shops vary in size, but 40 feet is considered a minium width. Provisions should be made for 150 square feet of floor space per student in the largest class. An additional 1,200 square feet is needed for workbenches, power tools, and other equipment. See Vocational Division Bulletin No. 284, "Buildings, Equipment, and Facilities for Vocational Agriculture Education," for other recommendations pertaining to heating, size of class, safety practices, tools, lighting, ventilation, and other facilities and features for a farm mechanics shop.

It is essential that sufficient tools and equipment of the proper type and quality are provided for all five areas of training. The budget must be adequate to provide and maintain needed supplies, equipment, and tools for the complete program. Instructional time in farm mechanics has been increased from 40 percent or less of the total time devoted to vocational agriculture to as much as 60 percent in highly mechanized sections. Farm mechanics instruction is enhanced as to efficiency and production when operating under the longer or double period schedule. Safety should be stressed in each job where it applies and given special emphasis as needed. The attire of all should be in keeping with safety practices, cleanliness, and work efficiency.

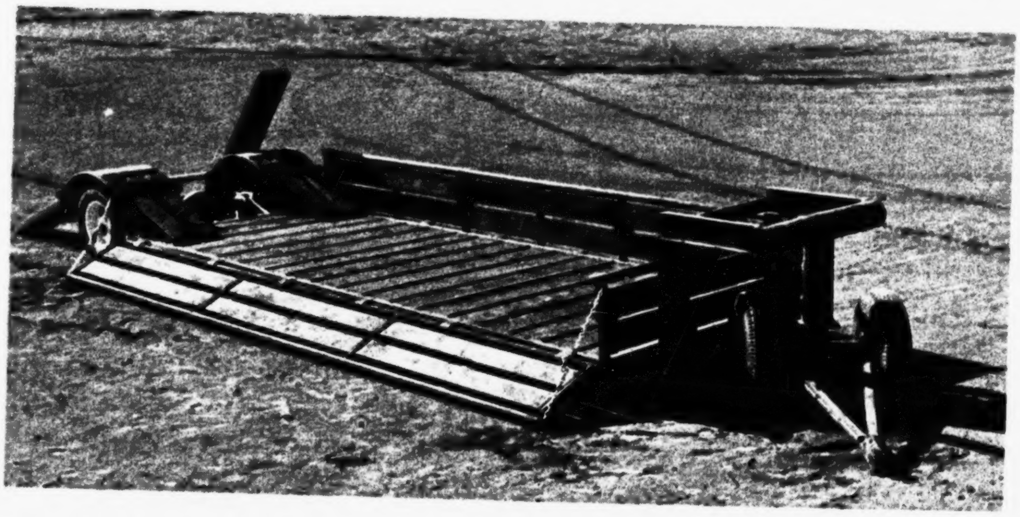


Figure 9. A heavy duty implement carrier made in the farm shop that may be easily loaded or unloaded.

Vocational agriculture in high school shares time with several forms of instruction, both required and elective. Since vocational agriculture is often terminal, it behooves those responsible for such training to use the time available in the most effective manner. In farm mechanics the use of double class periods and the blocking of from 2 to 4 weeks for such training are desirable plans. Some of the advantages of one or both of these plans include:

1. More net class time in work is available for actual shop production.
2. Students will bring in more shop jobs when such training continues over a definite known blocked period of time.
3. The train of thought on skill learning or construction is less likely to be broken.
4. The learning of more essential shop skills and the improvement of mechanical abilities are made possible.
5. Parents are more agreeable to having their farm machines serviced or reconditioned when the work is performed expeditiously.
6. Shop projects take up space for a minimum time period.
7. Fewer unfinished jobs remain in the shop when classes are systematically rotated between classroom and shop.

In order to assure practical training in the servicing, adjusting, and maintenance of machines used on local farms it is essential to have facilities available for transporting these machines and the larger constructed items between the farms and the school. Many departments of vocational agriculture have machinery trailers which the students constructed in the school shop for this purpose and which are pulled by a truck or other mobile power provided to the department.

Instructional Procedures

In each of the five areas of training in farm mechanics there are many jobs to be analyzed by the teacher and then presented in a well-planned procedure. Altogether there are four logical steps and these are: (1) Preparation for the teacher, (2) presentation by the teacher, (3) application, and (4) testing. Demonstration is a part of the presentation step for each job. Following a demonstration, discussion topics are considered and may be considered again at the end of the application step. Some of the jobs given here make use of only the preparation and presentation steps, but the teacher would also include application and testing steps.

Preparation for the Teacher

The teacher of vocational agriculture must be thoroughly familiar with all phases of each farm mechanics job involving the agriculture of the community served. This familiarity in needed skills and abilities is gained through technical training, practical experience, and the careful study of appropriate references. Teacher-training institutions have the responsibility of providing preservice and inservice training in these mechanical skills and abilities to prospective teachers and those employed as teachers of vocational agriculture. The upgrading of inservice teachers is a continuing process to meet the needs of an ever-changing agriculture on the farm. Supervisory staff members through periodic visits to local departments of vocational agriculture need to determine the adequacy of the farm mechanics training offered and the ability of the teacher to provide such instruction. Where the need for inservice upgrading is noted, plans should be made for providing such training on either an off-campus or on-campus basis and through special workshops. These workshops are often for a specific farm machine or for a group of farm machines used in performing the same or similar functional jobs on the farm.

In each of the five recognized areas of farm mechanics as listed in Chapter I there are myriads of jobs that must be demonstrated by the teacher to the vocational agriculture classes. Such demonstrations usually involve the entire class but on occasion may be presented only to small groups or to individuals. Before starting a demonstration, it is imperative

Figure 10.—Demonstrating use of a fuel flow meter and reading of dial for a PTO dynamometer.

to have on hand the essential tools, equipment, supplies, and facilities that are in good condition. Prior to the demonstration the teacher should be thoroughly familiar with all phases of the job to be taught and the logical procedures to follow in each of the steps to be presented. Adequate preparation by the teacher for each job demonstrated is basic to the success of a farm mechanics training program.

Presentation by the Teacher

The teacher of vocational agriculture is to demonstrate each of the jobs which the students are to study and perform. Some of these jobs will require more than one class period to demonstrate. If the job pertains to a farm machine, it is desirable to use more than one make or model for such demonstrations. Locate the machine where all of the students can observe each step of the demonstration.

To be effective the demonstration must create an interest in the class members regarding the job being taught. Throughout and following the demonstration, encourage discussion, and proceed at a rate which will assure that all students fully understand each step presented. Calling upon a student to repeat the demonstration helps to keep the group on the alert. It may be necessary to demonstrate again certain parts of a job to clear up any doubtful points or misunderstandings. Throughout the demonstration the selection, purpose, and use of each tool and piece of equipment is to be fully explained at the proper time.

Application

Following the demonstration, each student, using the appropriate job sheet, will perform on the machine used the steps presented by the teacher. Each student, individually, or in a small group, should select and work on a machine best suited to his farming needs. The teacher is to observe the work being done and counsel with the student as he performs each step. Specific classroom or shop periods should be used for Discussion Topics in connection with each job demonstrated.

Discussion Topics

In order to encourage students to obtain a better understanding of the job demonstrated, have them participate in several discussion topics. These topics are best when drawn from the class, but may need to be supplemented by the teacher. For example, if the job is on servicing an air cleaner some of the discussion topics might be as follows:

1. What is the importance of the proper weight of oil in an air cleaner cup?
2. Why use new oil rather than used oil in the cup of the air cleaner?
3. How is engine operation affected by partial plugging of the air cleaner screen?
4. How is carburetion affected by improper oil level in the air cleaner?
5. What is the primary purpose of auxiliary cleaner or precleaner?
6. How is the life of the tractor affected by proper servicing of the air cleaner?
7. How is fuel consumption affected by proper servicing of the air cleaner?
8. How much air is used with each gallon of fuel?
9. What are the general engine conditions noted when excessive dirt is entering the engine?

Testing

The maintenance and construction work performed by each student in the farm mechanics shop must be checked carefully before the machine is removed from the shop. During the periodic visits to the home of each student for the purpose of supervising the farming program check and advise on maintenance jobs performed at home.

It is well to have a sample set of questions for each job presented. Other questions may be prepared as needed following the periods devoted to discussion topics. Use the test after the students have performed the jobs on a machine made available in the farm mechanics shop of the high school.

Chapter III. Objectives and Procedures In Farm Mechanics

General Objectives

1. To develop an understanding and appreciation of the physical and mechanical aspects of farming, and the importance of farm mechanics to farming as a whole.
2. To develop skills and abilities sufficient to assist with and perform the more technical problems of the farm operator which involve engineering applications.
3. To develop abilities sufficient to perform the common and important operations or processes involving the selection, care, and use of tools, machinery, and mechanical equipment.
4. To develop the ability to make sound farm management decisions in each of the five areas of farm mechanics.
5. To develop the ability to plan, organize, and equip a school farm mechanics shop and a home farm shop.

The teacher's overall goal is to develop understandings of basic principles involved as well as judgment and ability in the areas taught: Consider the following statements of abilities under each of the five areas as suggestive and not as complete and comprehensive or meeting the farm mechanics training needs adequately in all vocational agriculture departments.

Farm Power and Machinery

A. Objectives of the Instruction

Develop ability to:

1. Recognize and identify the fundamental principles involved in machines and the relationship of mechanisms and systems to processes and functions.
2. Select power units and machines with regard to cost, to adapting systems of machines to types of farming, and to coordinating individual machines with other components of the machinery system; consider size and number of power units, hours of utilization, annual cost, and availability and cost of dealer service and custom rental.

3. Operate, adjust, service, and maintain spark-ignition and diesel-type farm tractors.
4. Operate, adjust, and service field machines: Lubricate; recognize malfunction; make operating adjustments; hitch implements properly; and calibrate planting, fertilizing, and spraying equipment.
5. Locate and remedy common operating troubles due to wear of parts, breakage, misalinement, and other causes.
6. Plan and execute a program of preventive maintenance, including protection shelter, rust prevention, periodic inspection and adjustment to compensate for wear, and repair in anticipation of breakage and improper function.
7. Understand the principles and operation of small gasoline engines. Make repairs and replace parts correctly.
8. Recognize the need for repairs involving the use of specialized tools and equipment, and determine appropriate methods of getting such work done by a qualified service agency.
9. Adapt and modify machinery to satisfy local conditions, such as trash-cover control, hillside operation, specialized crop use, and multiple hitching.
10. Determine and use safe operating practices with special emphasis on proper speed, protection from moving parts, and stopping the machine to adjust and remove obstructions and for refueling.

B. Suggested Procedures for the Teacher

1. Make a systematic analysis of the farm machinery and power needs on a particular farm and calculate the estimated machine, power, and labor costs of performing certain operations or producing certain crops. Consider the size and type of farm, crop rotation, acres and quantities of various crops grown annually, use of crops, time available for harvesting, storage, and possibilities for custom work.
2. Perform systematically the various tractor maintenance and service jobs, including lubrication, carburetion, ignition, engine tune-up, trouble shooting, and adjustments.
3. Study the major functions, adjustments, and safe operation of farm machines, such as the disk or moldboard plow, mower, combine harvester-thresher, baler, forage harvester, or corn picker. Study fundamental principles related to care, maintenance, and safe operation to provide an understanding of the reasons for such practices. Perform maintenance and repair operations.
4. Plan the repairing and reconditioning of one or more machines. Actually perform as much of this work as time and facilities permit. Make a thorough examination to determine the repair work needed, and make a list of all worn or damaged parts that need replacement. Obtain and install repair parts, emphasizing careful and proper assembly and adjustment. Place special emphasis on efficient methods of acquiring these parts from suppliers, identifying parts by make, model, and number.
5. Hitch a moldboard plow or other machine to a tractor and analyze and discuss the effect of different hitch adjustments. Field demonstrations and student participation are essential to understanding.

6. Make extensive use of operator's instruction manuals, servicemen's repair manuals, appropriate slide films and motion pictures available from manufacturers and other agencies. Use these as aids and as supplements to laboratory experience.
7. Have students perform minor repair of internal-combustion engines to acquaint them with operating principles and need for care and cleanliness in quality workmanship. Study the principles of small gasoline engine operation and servicing procedures.
8. Visit and become acquainted with local farm equipment dealers. Know the types of machines they supply and the facilities and servicing methods in their shops. Encourage and enlist their cooperation in this phase of the vocational agriculture program and arrange for the students to visit their facilities.

Soil and Water Management

A. Objectives of the Instruction

Develop ability to:

1. Make land surveys, locate corners, read soil survey and aerial maps, and run levels and contours by using the farm level. Locate and place grade stakes, and make contour maps.
2. Plan terracing and farm drainage systems. Estimate costs of construction and maintenance.
3. Plan and lay out typical irrigation systems, considering the advantages and limitations of the various systems.
4. Maintain irrigation and drainage systems, including the upkeep of terraces, spillways, and ditches; service overhead irrigation layouts, and correct defects in both drainage and irrigation systems; apply fertilizers in irrigation water.
5. Plan and lay out farm ponds and reservoirs, including the selecting of the appropriate site; calculate the expected flow and capacity; determine the procedure in pond and reservoir construction; construct adequate spillways; provide outlets; and use practices that preserve earthen reservoirs and embankments.
6. Relate equipment and tillage practices to soil erosion control.

B. Suggested Procedures for the Teacher

1. Determine land area; locate bench mark; establish stations; record data; make rough sketches; and locate and place grade stakes.
2. Relate soil type, rainfall characteristics, and the amount of run-off to the following factors: vertical and horizontal distances between terraces; slope and spacing of drain tile; height and width of terrace; slope or fall of terrace, waterways, and outlets.
3. Take field trips to observe recommended construction procedures as well as finished projects in pond, irrigation, and drainage structures. Also observe tillage methods used to control wind and water in soil erosion.
4. Plan an economical irrigation system for a given farm, considering the water supply available, type of soil, topography of the fields, seasonal rainfall, and moisture needs of the crop. Make an estimate of costs and benefits of the system.

Farm Buildings and Conveniences

A. Objectives of the Instruction

Develop ability to:

1. Lay out a farmstead and plan a coordinated farm improvement program; evaluate existing buildings; analyze the need for new or reconditioned structures; plan new buildings; develop a maintenance and improvement program recognizing basic requirements for farm structures.
2. Plan buildings for utilities and production equipment to meet the operating needs of the farmer, such as elevators and conveyors; select, install, and maintain water distribution and disposal systems, light and power, feed-storage, handling, and processing devices.
3. Recognize and meet requirements of farm animals and poultry for environmental and sanitation control, such as temperature, ventilation, light, and moisture.
4. Select suitable building materials for specific uses, including durability, fire resistance, functional performance, strength, ease of application, availability, economy, and appearance. Recognize standard commercial units and grades; estimate quantities; and determine construction costs.
5. Recognize good construction methods and standard building materials.
6. Select lumber, hardware, and other building materials, and calculate cost of material.
7. Supervise and assist with construction and maintenance of farm buildings and equipment.
8. Do painting and glazing. Apply wood preservatives, and control damaging pests.
9. Construct and maintain adequate farm fences.
10. Recognize and be prepared to correct common occupational hazards to life and property: fire, accident, wind, water, lightning.

B. Suggested Procedures for the Teacher

1. Survey and analyze the farm structures and equipment on well-planned farmsteads. The survey should include type of farming, existing buildings, feed lots, equipment, living snow fences, windbreaks, land slope, surface and subsurface drainage, field layout, roads, fences, and conservation practices.
2. Replan a selected farm; a balanced building program for livestock, crops, and conservation practices.
3. Plan for new construction after reviewing functional design of buildings. Review plans for poultry, livestock, machine storage, and farm service centers, as required for a particular farming operation.
4. Plan and take field trips to inspect well-constructed farm buildings and construction of buildings inspected, including wood preservation use and control of pests.
5. Select standard building materials and demonstrate accepted methods of application for economy and service.

6. Determine water requirements other than for irrigation of a farm, and select a water supply and disposal system to meet its needs.
7. Select or prepare a plan for one or more building units; make a complete bill of materials; and estimate construction costs.

Farm Electrification

A. Objectives of the Instruction

Develop ability to:

1. Plan wiring systems for adequacy, convenience, and safety, including determination of probable future electric loads. This may necessitate rewiring.
2. Provide adequate illumination by selecting lighting equipment and locating it in the yards, lots, buildings, and work areas.
3. Select electrical home appliances and farm equipment, including motors and controls. Consider safety, quality, energy consumption, life of appliances, and servicing.
4. Adapt electricity to the farm activities, coordinating the equipment with the size and arrangement of the farm buildings.
5. Repair, service, and maintain electrical equipment. Locate and correct troubles and hazards in connection with fuses, controls, switches, fixtures, cords and wiring, motors, heating appliances, and lamps.
6. Install electrical equipment taking into consideration power transmission, equipment ventilation, servicing, and safety.
7. Perform maintenance jobs and simple wiring installations which can be done safely.

B. Suggested Procedures for the Teacher

1. Make a sketch of the farmstead showing the location of the buildings, and list the existing and proposed electrical equipment to be used in each. Mark with proper symbols the location of switches, lighting fixtures, and appliance outlets. Visit electrical suppliers or equipment dealers and prepare a list of needed fixtures and equipment with approximate costs.
2. Check with a local power-supplier representative and electrical inspectors for recommendations for wiring new buildings and rewiring old buildings.
3. Plan wiring or rewiring layouts and lighting in buildings for adequacy, convenience, and safety.
4. Compare two or more pieces of equipment, such as feed mixers or water pumps, and judge them on safety, quality, durability, and provisions for adjusting, cleaning, and lubricating.
5. Compute probable energy consumption of different appliances from name plate data or from tests. Figure sizes of wires for one or more motors on specified jobs using name plate data.
6. Make cost estimates for doing such jobs as brooding pigs, elevating feed, and grinding feed, using electricity as a source of heat or power compared to other methods.

7. Apply knowledge of circuit and motor protection by proper selection of fuses, circuit breakers or controls, and by selecting wire sizes, grounding, polarization, and 3-wire convenience plugs.
8. Recognize installation and maintenace difficulties which require the service of trained personnel.

Farm Shop Work

A. Objectives of the Instruction

Develop ability to:

1. Promote the establishment of a well-equipped home farm shop or farm service center.
2. Supervise and assist in planning, equipping, arranging, managing, and maintaining a school farm mechanics shop. Recognize shop terminology and names of working equipment and supplies.
3. Select hand and power tools and shop equipment for the school agricultural mechanics shop and home farm shop, including makes, models, sizes, quantities, and grades.
4. Sharpen, repair, maintain, and safely use the common shop tools and equipment.
5. Install, safely use, service, and maintain power tools found in the agricultural mechanics shop.
6. Do electric arc and oxyacetylene welding, including cutting, bronze welding, and hard surfacing.
7. Do hot metal work, including bending, shaping, and heat treating.
8. Do cold metal work, including cutting, drilling, filing, tapping, threading, riveting, and bending.
9. Do sheet metal work, including cutting, bending, soldering, and fastening.
10. Do pipe and tubing work and make simple plumbing repairs.
11. Do concrete work, including building forms, testing materials, preparing mixes, placing, finishing, and curing; and laying concrete and masonry building units.
12. Recognize and guard against dangers and hazards connected with the use of tools and equipment.

B. Suggested Procedures for the Teacher

1. Teach the farm shop skills, abilities, and judgments by providing practical experiences and relating these to actual farming situations.
2. Place emphasis on good work habits and learning rather than on volume of projects completed. Specifically, quality control and standards of workmanship should be consistent with the particular project involved.
3. Select projects for construction, repair, and maintenance by students that are of practical value. These projects should be typical of those emphasized in farm mechanics courses for high school students, young farmers, and adult farmers.
4. Train the students to become safety conscious as a result of employing standard safety practices throughout the farm mechanics

courses. These practices include the use of color coding, ventilating systems, machine guarding shields, and safe work habits.

5. Select high school teacher-training centers that have equipment and facilities which are equal to the better equipped and organized high school farm mechanics shops in the State. For effective skill development the teacher-training institution needs to have a farm mechanics shop with equipment that is at least equal to the best high school farm mechanics shops in the State.

Planning and Organizing Home Farm Mechanics Shops

A profitable farm business most often includes a well-planned and utilized home farm shop. Many farmers establish their farm shop in a part of an existing building, while others construct a building specifically for this purpose. In such a location it serves as the farm center from which radiates the mechanical operations. Generally speaking, the on-farm shop and the machinery storage facility should be adjacent to each other, or in the same unit, and located preferably between the house and outlying farm service buildings. In such a location it serves best as the nerve center of farm service operations. Where shop space is inadequate a paved patio adjacent to the shop and large entrance door provides an additional economical service area. It is well to have this area serviced with water, lights, compressed air, and power outlets.

When planning a home farm shop some of the factors to consider are: adequate size; convenient location; sufficient ceiling height for equipment; doors that are wide enough and of sufficient height for the largest farm equipment; a durable floor that is easy to maintain; construction material that is economical, serviceable, and fire-resistant; adequate lighting; heating system; availability of water; approved wiring for all power outlets; safe storage for tools and supplies; and separate storage for flammable products such as fuels and oils.

Planning and Organizing School Farm Mechanics Shops

A teacher of vocational agriculture is charged with the responsibility to offer training in all five areas of farm mechanics. In order to perform this essential training program, adequate facilities, equipment, and supplies must be available. Details pertaining to such needs may be found in Vocational Division Bulletin No. 284, "Buildings, Equipment, and Facilities for

Figure 11.—A home farm shop that can be heated for cold weather use.

Vocational Agricultural Education," and available from the U.S. Government Printing Office, Washington, D.C., 20402. *Also see* "Setting Up the Program" in Chapter II.

Chapter IV. Farm Power and Machinery

IN THIS CHAPTER consideration will be given to farm power units (tractors, stationary engines, and transportation units) and to farm machines that are generally used in the five functional areas of farming. (See page 65.)

Activities in this area of farm mechanics will be presented in greater detail than for the other four areas because:

On many farms the investment in such equipment equals or exceeds the value of the land farmed.

Equipment comprising farm power and machinery is quickly expendable if not properly serviced and maintained.

More detailed analysis of the activities in this unit serves as an example to follow in the other four areas.

Job activities in the other four areas are often dependent upon the machines in the farm power and machinery area.

FARM POWER UNITS

Power is and has long been a major motivating factor in agriculture's progress. Several kinds of mechanical power are used on the farm, but the presentation here will be limited to engines of the internal combustion type as they apply to the farm tractor, stationary engines, and the truck, but the information will apply more specifically to tractors.

Tractors

The farm tractor, the main source of power for the machines on the farm, is presented here with a general discussion, job analysis, and discussion topics. Objectives and suggested procedures are listed in Chapter III under the topic Farm Power and Machinery.

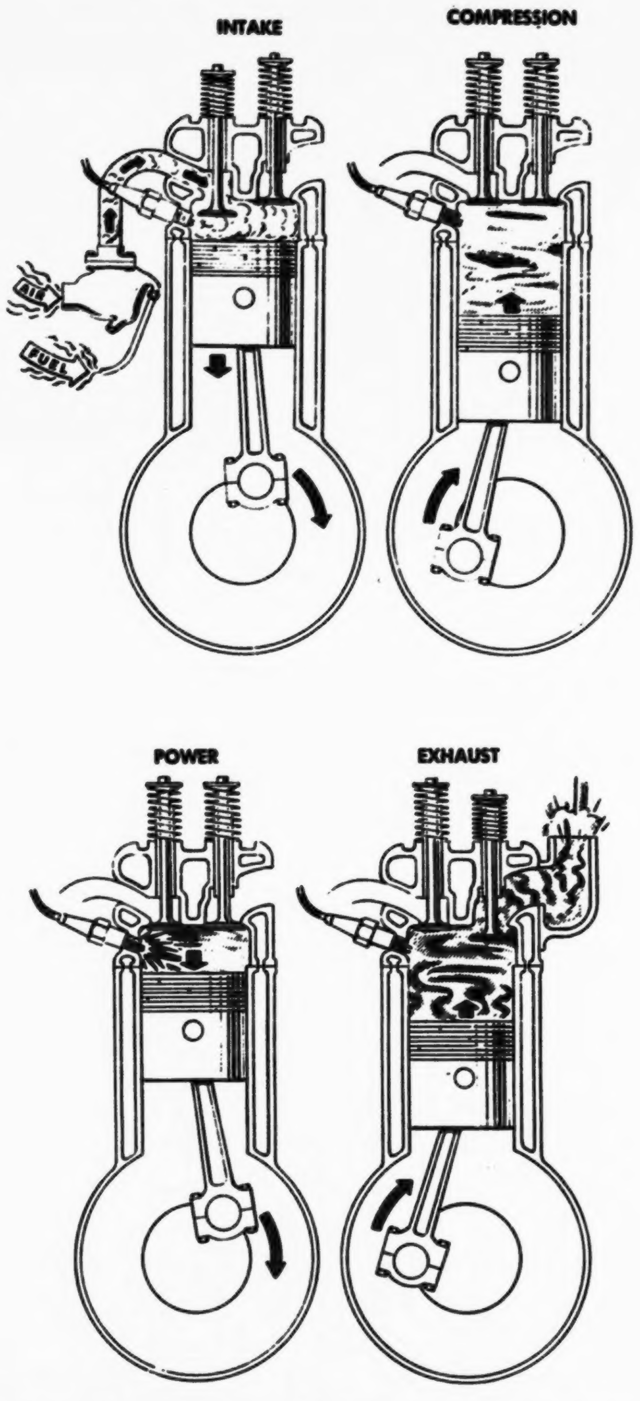

INTAKE
COMPRESSION
AIR
FUEL
POWER
EXHAUST

Figure 12—Operation of a 4-stroke cycle gasoline engine.

Farm tractor maintenance includes those daily and periodic service needs of tractors which assure the best performance, utmost efficiency, and maximum years of satisfactory operation. Proper tractor servicing reduces the number of field breakdowns and the need for major reconditioning. Major

The 2-stroke cycle diesel engine.

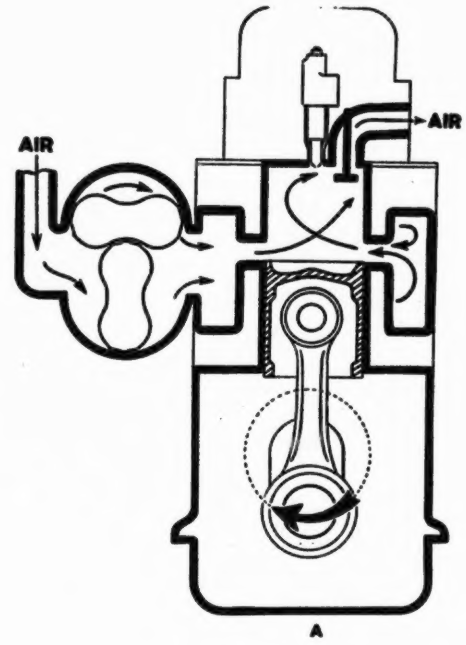


Figure 13-A.—When top of piston on downward stroke clears intake port air is forced by a blower into cylinder space vacated.

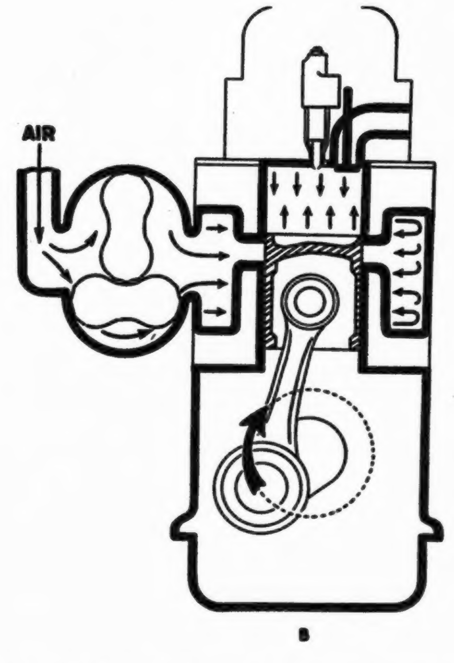
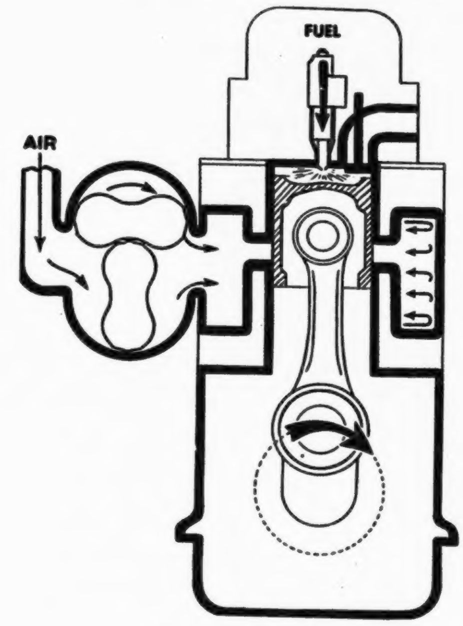
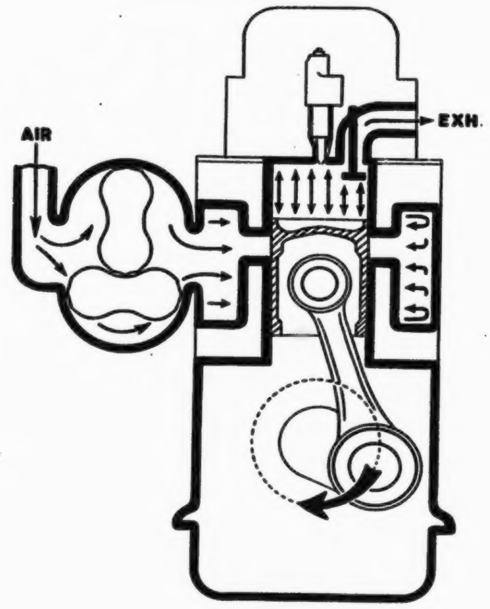


Figure 13-B.—On up-stroke of piston exhaust valves are closed and air is highly compressed.



C

Figure 13-C.—Compression produces sufficiently high temperature for spontaneous ignition of the fuel, which is injected near the end of the compression stroke. Heat of combustion causes forceful expansion of cylinder gases against piston, resulting in power stroke.



D

Figure 13-D.—Exhaust valve opens, just before top of piston on downward stroke reaches forced air intake ports. When ports are uncovered burned gases are further cleaned out by air from the blower.

reconditioning of a tractor is a job to be performed by a qualified serviceman in a shop having essential equipment and tools which a farmer cannot normally afford to own. Jobs in farm tractor maintenance should be presented in a logical order. Engines commercially available to farmers are fueled by gasoline, diesel oils, and LP-gas. These involve engines operating on different cycle principles.

Cycle.—The operating principles of engines commonly used include the 4-cycle and 2-cycle with the former being more prevalent. In an internal combustion 4-cycle engine, a cycle comprises 4 strokes for each piston (1, intake; 2, compression; 3, power; 4, exhaust) performed during two revolutions of the crankshaft. An interval, or period of time occupied by one round or course of events, recurs in the same order in a series. In a 2-cycle (2-stroke cycle), the four operations are performed in 1 revolution. On the upstroke, the piston exhausts burned gases. Near the end of the stroke, the fuel intake enters under pressure and completes compression for the explosion of the power stroke.

Selecting power units.—The job of efficiently selecting field machinery is that of adjusting the factors of power availability, implement performance, labor, timeliness, and costs so balanced as to assure an optimum economic return. Selection of power units, therefore, depends upon several economic considerations. Pride and prejudice are factors in such selection, but the profit motive will be stronger as farming continues to change from a way-of-life to a business. Through practical farm management practices, it is recognized that selection of the power units and accompanying machines is more than a self-gratifying exhibit, for such tools must pay their own way. The farmer who will remain in business must answer successfully the questions of how big, how many, and how much.

Studying operator's manual.—While basically similar, each make of a power unit has many individual characteristics. Designing engineers are constantly endeavoring to develop a better machine and each has his own ideas as to how this can be accomplished to best satisfy the needs of farmers. Responsibility for maintaining the power at full peak performance rests primarily with the operator. Performance of the tractor or other power unit depends largely on how well it is maintained. Tractor manufacturers furnish an operator's manual with each machine sold. Failure to consult the operator's manual frequently results in premature mechanical failure.

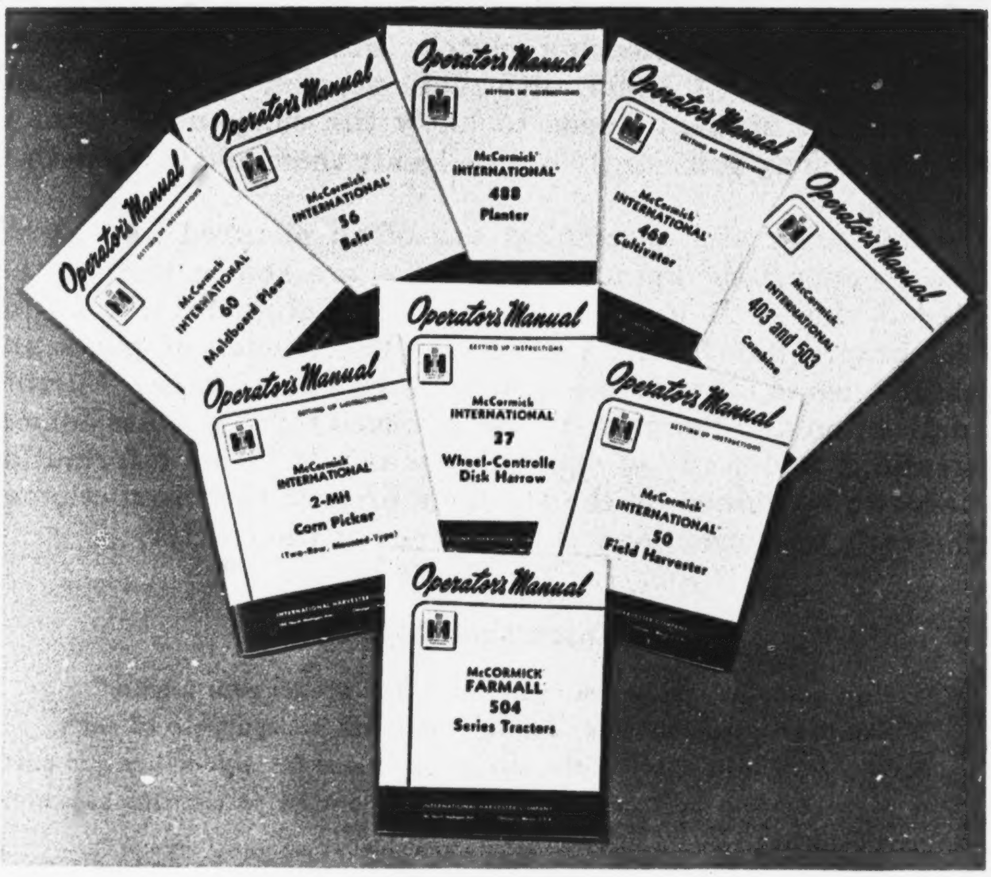


Figure 14.—There is an operator's manual available for each farm machine.

Some of the points that should be understood and which may be found in the operator's manual are:

1. Appropriate grade of fuel to use
2. Correct viscosity of oil to use in the crankcase
3. Correct viscosity of oil to use in the differential, final drive, and transmission
4. Recommended periods for lubrication
5. Proper inflation of tires
6. Recommended periods for service of storage battery
7. Use of safety shield to cover the power take-off
8. Proper care of the cooling system
9. Proper adjustment of the carburetor.

Maximum use can only be made of the operator's manual when it is kept conveniently available and clean. Commercial implement and tractor books having annual supplements are available.

Identifying tractor parts.—In order for a farmer to maintain his tractor effectively it is necessary to know the location and proper name for each assembly and its major parts. Some assemblies include steering, clutch, brake, differential, transmission, power take-off, drawbar, starter, generator, and valve. The student needs to know the component parts of each assembly sufficiently well to locate them and to know their purpose.

Such parts and assemblies are often pictured and identified in operators' manuals and some are shown through exploded views. It has proven helpful to students in learning the proper names and location on the tractor of parts and assemblies to identify these through numbered tags. Further instruction and training can be achieved through class demonstrations and study of operators' manuals. This information needs to be gained by the students prior to the instruction on the care, operation, and maintenance of the tractor.

Discussion Topics

1. How many assemblies can you name that are on your tractor?
2. Select an assembly and identify the parts and purpose of each.
3. Why is it desirable to know the proper name for assemblies and parts?
4. How can you best use the operators' manuals to identify assemblies and parts?
5. Why is it desirable to know the number and proper name when ordering a repair part?
6. How do changes of models affect name, size, and design of parts?

Observing safety practices.—Manufacturers of farm power units are constantly endeavoring to make equipment safer to operate by incorporating safety devices into the design of their machines. Regardless of precautions in designing and constructing machines, there always remains the human element in the operation of such machinery. If the operator removes these devices or renders them inoperative, he may injure himself and possibly others. These safeguards are placed on the tractor or other power units for a definite purpose and full use must be made of them.

When the individual is learning to operate the machine is the time to form correct and safe operating habits. The operator's manual should be studied carefully. Such manuals warn of dangerous practices, but when the tractor is in the hands of the operator it becomes the operator's responsibility to develop safety practices as well as to follow written instructions. It is the duty of each tractor operator to familiarize himself with the condition of his power units. Every repair and adjustment needed should be taken care of immediately.

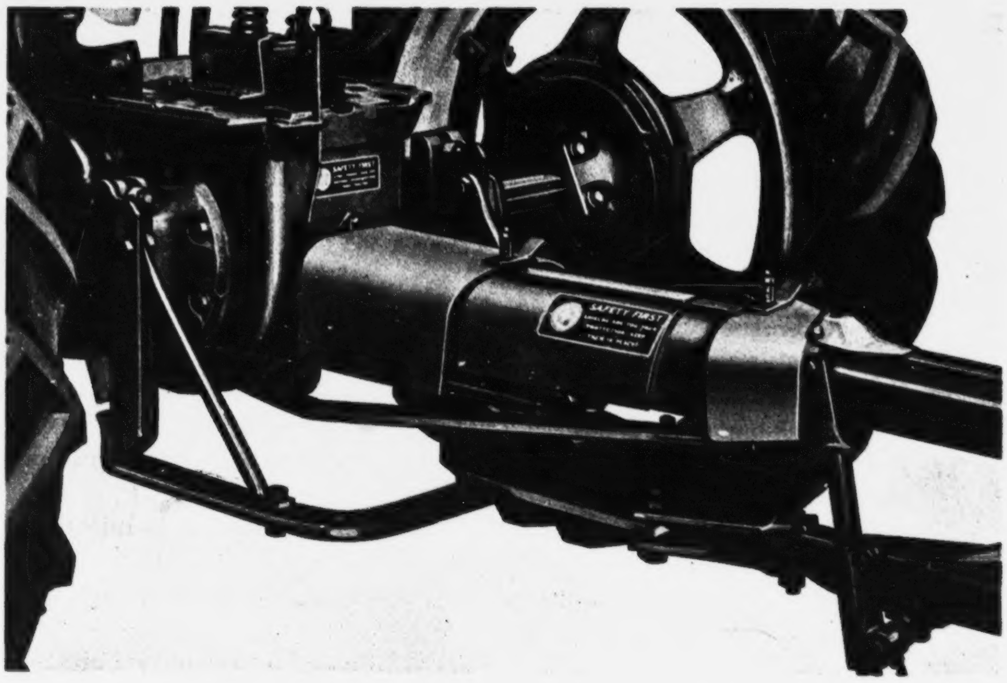


Figure 15.—A PTO safety shield in position. Note drawbar adjustment and linkage.

Objectives of safety practices as they pertain to the tractor are:

1. To teach students to be alert, and to note and correct any situation or condition that might cause an accident.
2. To encourage students to develop safety habits in the operation and maintenance of tractors and related farm equipment.
3. To promote safety thinking and correct attitudes among students and their coworkers.
4. To be as considerate and mindful of the safety of others as well as of his own safety.

Carefully planned and conducted demonstrations are essential to achieve the above safety objectives as they relate to farm power, machinery, and transportation. The teacher should demonstrate these activities as they relate to safety by:

1. Placing the gearshift lever in a neutral position before cranking engine.
2. Backing the tractor to a drawn implement for hitching, without standing between the tractor and the implement.
3. Removing and putting on a pulley belt safely. (Explain the danger of doing this while pulley is in motion.)
4. Showing how to ride safely on a tractor. (Explain the danger of riding on tractor drawbar or on the drawn implement.)
5. Investigating and correcting the cause of any unusual sound that may develop in the tractor or drawn equipment.

6. Showing how to refuel a tractor safely. (Explain the danger of refueling the tractor while engine is running or of spilling fuel on a hot engine.)
7. Removing a radiator cap properly from an overheated engine equipped with a pressure system.
8. Avoiding contact with fans and moving parts while engine is operating.
9. Stopping the power take-off before dismounting from the tractor.
10. Showing the maximum safe load of a tractor. (Explain that it can be expensive as well as dangerous to overload.)
11. Operating the tractor skillfully.
12. Showing space needed and proper speed for safe turning when pulling equipment.
13. Hitching a load to the drawbar only and taking up slack gradually to avoid a sudden jerk. (Explain danger of hitching to tractor axle.)
14. Engaging the clutch gently, especially when going up a hill or pulling a load out of a ditch.
15. Showing the need for keeping the tractor in the lowest required gear when going up or down steep grades.
16. Driving at speeds that assure safety over rough ground, crossing ditches, and on the highway.
17. Using precaution when working on a hillside, on rough ground, and where there are holes into which a wheel might drop.
18. Showing why it is essential to reduce speed before applying brakes.
19. Showing how both brake pedals under road conditions may be locked together to act simultaneously.
20. Driving to the right, keeping out of the way of traffic, when on a highway, and driving on the road shoulder whenever possible.
21. Following approved highway safety regulations, such as lighting, road signs, and designated traffic lanes.
22. Promoting tractor operators' contests to motivate and develop safe driving skills.

Discussion Topics

1. Why should a person avoid dismounting from a moving tractor?
2. Why is it dangerous to have extra riders on a tractor?
3. Why is it dangerous to refuel a tractor with the engine running?
4. What is the danger of standing between the tractor and the drawn implement when hitching?
5. What danger to the transmission is encountered in towing a tractor?
6. How should a tractor with drawn equipment be operated on a highway?
7. What safety features are built into your tractor?

Servicing Electrical System

The ignition system is the pulse beat of the tractor. It may be of the magneto type, or may originate in the storage

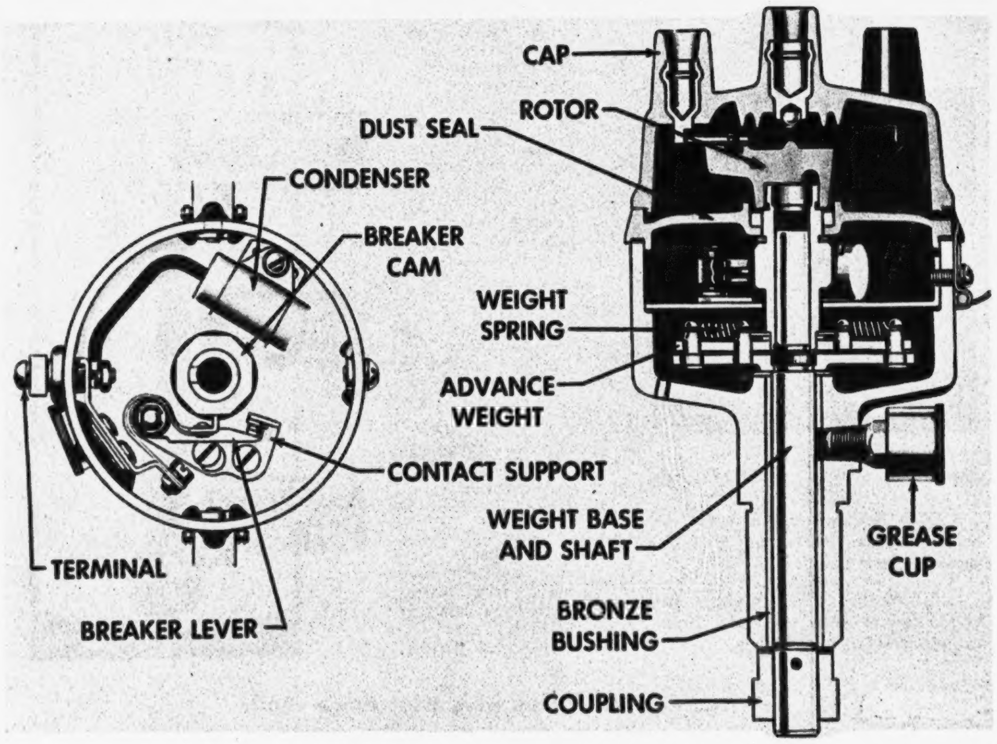

CAP
ROTOR
DUST SEAL
CONDENSER
BREAKER CAM
WEIGHT SPRING
ADVANCE WEIGHT
CONTACT SUPPORT
WEIGHT BASE AND SHAFT
GREASE CUP
TERMINAL
BRONZE BUSHING
BREAKER LEVER
COUPLING

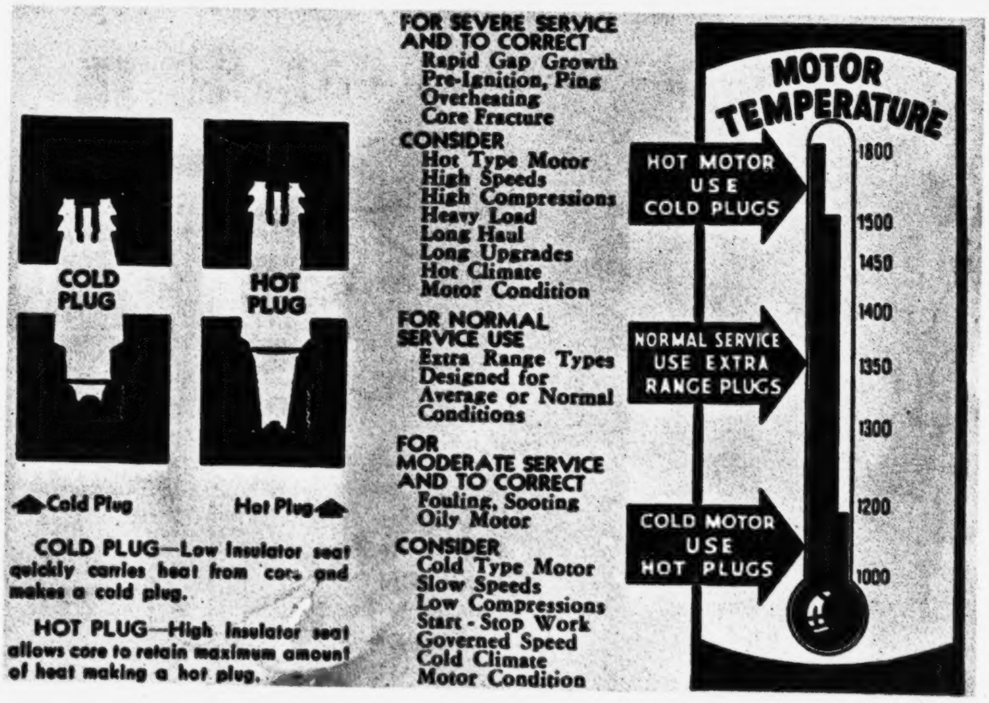
Figure 16.—Distributor with parts identified—battery ignition system.

battery from which it is carried to the spark plugs by the use of the distributor.

Timing magneto to the engine.—To demonstrate timing of the magneto to the engine, locate the tractor where each student can see the procedure. If the group is too large for this to be done, give more than one demonstration. Have on hand such tools and supplies as a screw driver, a combination box and open end wrench, a deep socket with a speed wrench, a thickness gage, a clean cloth, and a set of new breaker points for replacement if needed.

If the tractor has overhead valves, remove the valve inspection cover. Crank the 4-cylinder engine by hand until the exhaust valve on No. 4 cylinder opens and just closes. This means that piston No. 1, adjacent to the radiator, is on the compression stroke and near top dead center. Find the mark on the flywheel or pulley wheel that indicates that No. 1 piston is exactly on top dead center.

On L-head engines the compression stroke can be determined by removing No. 1 spark plug, placing a thumb over the spark plug opening, and cranking the engine until an outward air pressure is felt.



COLD PLUG
HOT PLUG
Cold Plug
Hot Plug
MOTOR TEMPERATURE
HOT MOTOR USE COLD PLUGS
NORMAL SERVICE USE EXTRA RANGE PLUGS
COLD MOTOR USE HOT PLUGS
1800
1500
1450
1400
1350
1300
1200
1000

COLD PLUG—Low insulator seat quickly carries heat from core and makes a cold plug.

HOT PLUG—High insulator seat allows core to retain maximum amount of heat making a hot plug.

FOR SEVERE SERVICE AND TO CORRECT
- Rapid Gap Growth
- Pre-Ignition, Ping
- Overheating
- Core Fracture

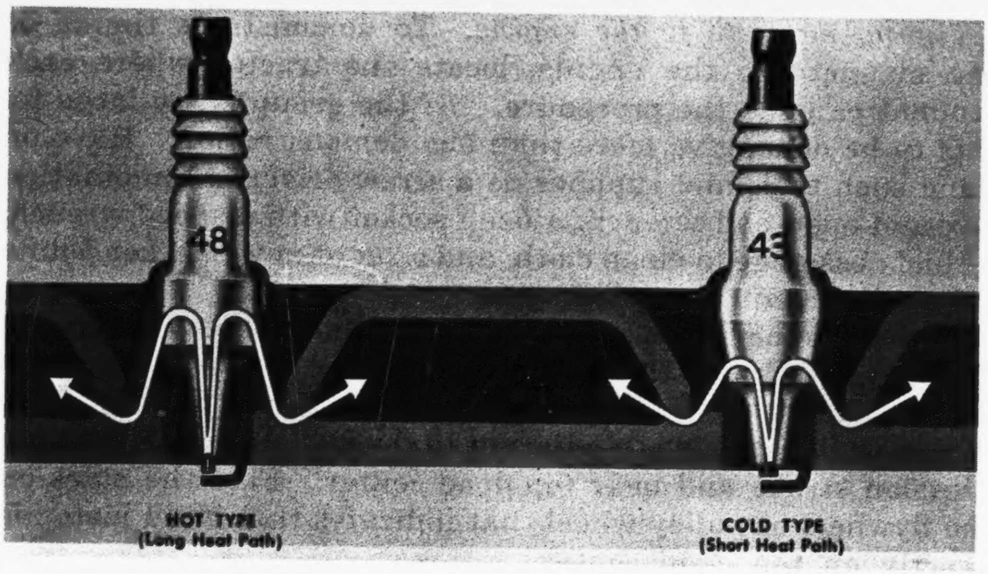
CONSIDER
- Hot Type Motor
- High Speeds
- High Compressions
- Heavy Load
- Long Haul
- Long Upgrades
- Hot Climate
- Motor Condition

FOR NORMAL SERVICE USE
- Extra Range Types Designed for Average or Normal Conditions

FOR MODERATE SERVICE AND TO CORRECT
- Fouling, Sooting
- Oily Motor

CONSIDER
- Cold Type Motor
- Slow Speeds
- Low Compressions
- Start - Stop Work
- Governed Speed
- Cold Climate
- Motor Condition

Figure 17-A.—Spark plug heat range chart.



48
43
HOT TYPE
(Long Heat Path)
COLD TYPE
(Short Heat Path)

Figure 17-B.—Showing heat dispersion for hot and cold spark plugs.

The spark plug

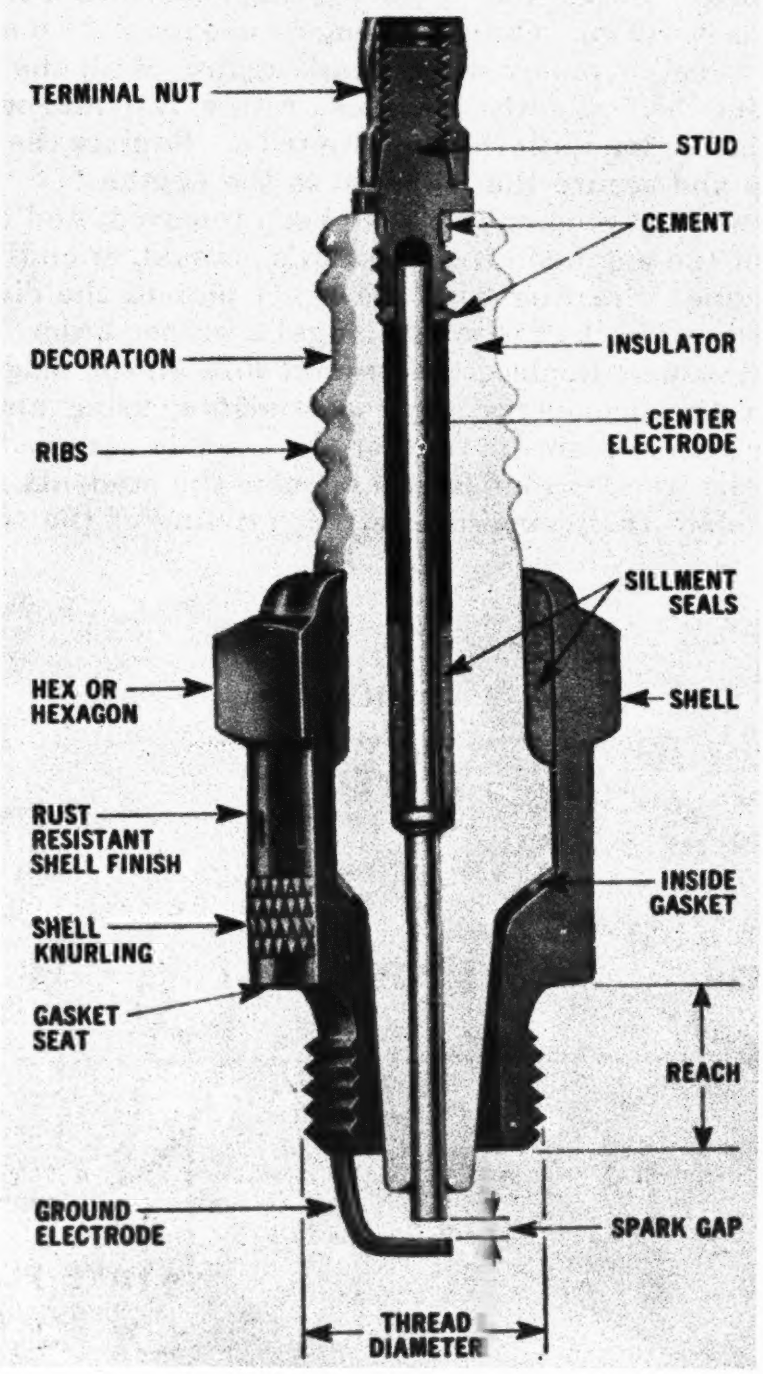

TERMINAL NUT
STUD
CEMENT
INSULATOR
DECORATION
CENTER ELECTRODE
RIBS
SILLMENT SEALS
HEX OR HEXAGON
SHELL
RUST RESISTANT SHELL FINISH
INSIDE GASKET
SHELL KNURLING
GASKET SEAT
REACH
GROUND ELECTRODE
SPARK GAP
THREAD DIAMETER

Figure 17-C.—Cutaway view of a spark plug.

With the distributor cover removed from the magneto, locate the rotor in position to deliver spark to No. 1 cylinder, using the left hand to keep the rotor in place while magneto coupling is meshed to the engine. Push the magneto toward the engine as far as it will go. Crank the engine one revolution and check the flywheel or pulley wheel mark again. With the magneto mounting bolt slightly loosened, rotate the magneto away from the engine until the impulse trips. Replace the distributor cap and secure the magneto to the engine.

If the spark plug cables have been removed, find the firing order of the engine in the operator's manual, or on the side of the engine. Starting with the No. 1 post of the distributor, place the wires to the spark plugs in proper order. Replace the coil cable. Replace the ground wire on the magneto.

After the demonstration, the students, using appropriate tractor manuals, should work on the tractors assigned to them. When the work is completed assemble the students and have them relate their experiences. For timing of the spark in a

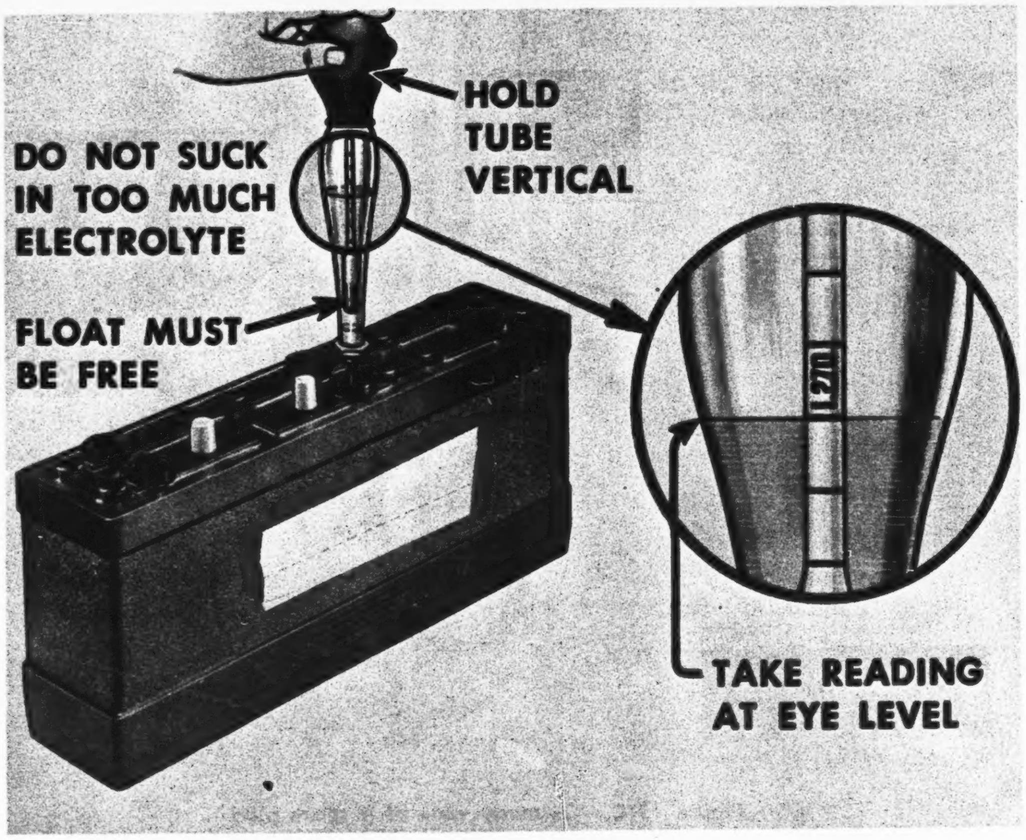

HOLD TUBE VERTICAL
DO NOT SUCK IN TOO MUCH ELECTROLYTE
FLOAT MUST BE FREE
1.270
TAKE READING AT EYE LEVEL

Figure 18-A.—Testing the storage battery electrolyte for specific gravity. Other hydrometers are used to test antifreeze solutions.

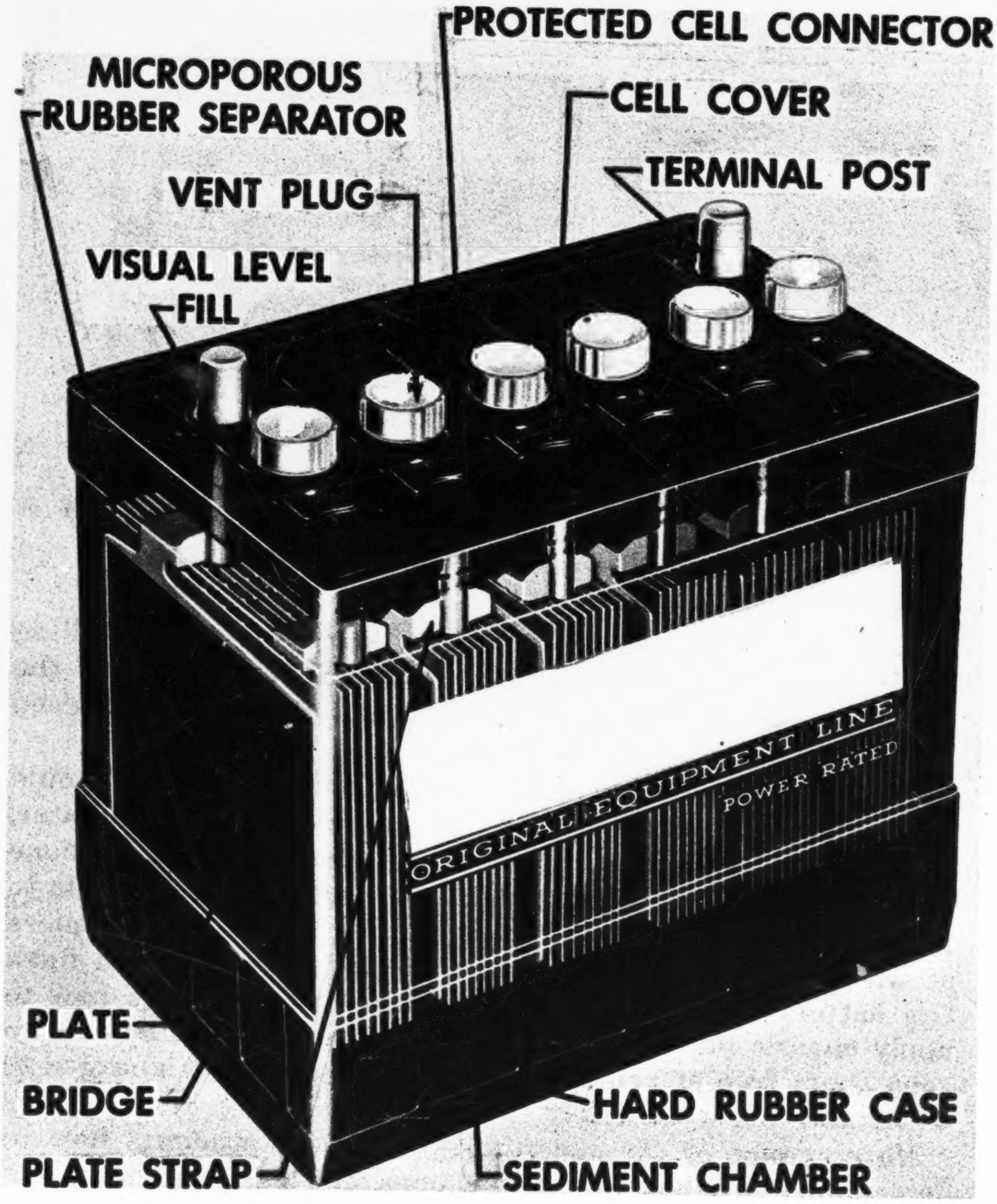

PROTECTED CELL CONNECTOR
MICROPOROUS RUBBER SEPARATOR
CELL COVER
TERMINAL POST
VENT PLUG
VISUAL LEVEL FILL
ORIGINAL EQUIPMENT LINE
POWER RATED
PLATE
BRIDGE
PLATE STRAP
HARD RUBBER CASE
SEDIMENT CHAMBER

Figure 18-B.—Cutaway view showing parts of a storage battery.

battery ignition system refer to the appropriate operator's manual.

Cleaning and testing spark plugs.—Spark plugs should be on hand that are designated as hot, medium, and cold types. Show when each type of plug is used and what will be the result when they are used incorrectly. Using a spark plug cleaner tester, demonstrate the cleaning and checking of spark plugs. Then have each student clean and test the spark plugs on the tractor assigned to him.

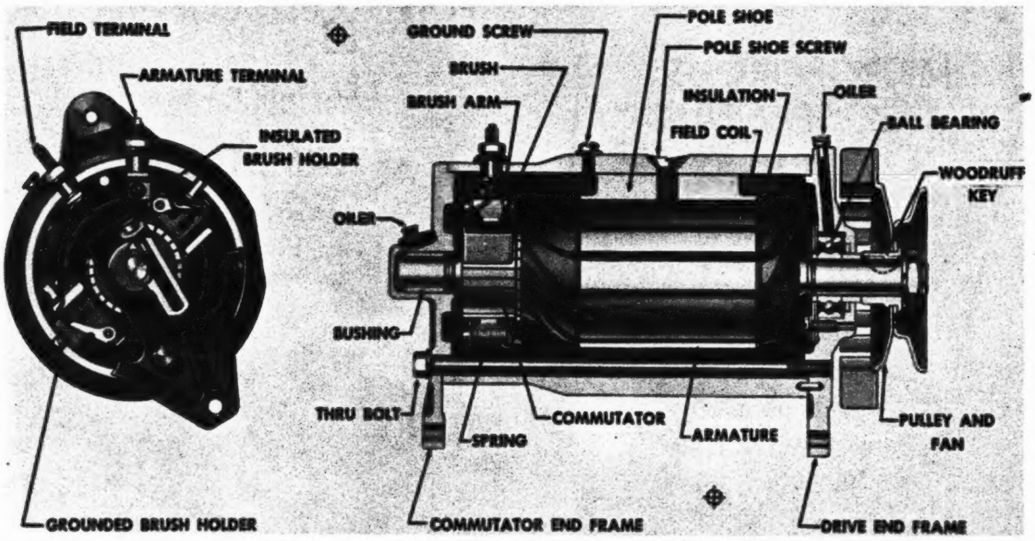

FIELD TERMINAL
ARMATURE TERMINAL
INSULATED BRUSH HOLDER
GROUNDED BRUSH HOLDER
GROUND SCREW
BRUSH
BRUSH ARM
OILER
BUSHING
THRU BOLT
SPRING
COMMUTATOR
COMMUTATOR END FRAME
POLE SHOE
POLE SHOE SCREW
INSULATION
FIELD COIL
ARMATURE
OILER
BALL BEARING
WOODRUFF KEY
PULLEY AND FAN
DRIVE END FRAME

Figure 19.—Generator with parts identified.

Demonstrate the correct method of removing and installing spark plugs. Examine the spark plug gaskets and show the difference between used and new ones. Explain why a deep socket wrench should be used.

Care of storage battery.—The storage battery exterior should be kept clean of dirt and acid. Using baking soda and water, demonstrate the proper procedure of cleaning. This is done by flushing the battery exterior with water, applying soda to the top of the battery, and then stirring it with a small piece of wood. After all of the reaction has stopped, again flush the battery surface with water. Show the students how to apply chassis lubricant to the cleaned posts of the battery to keep them free of acid. Keep battery sufficiently charged to withstand cold weather.

Maintenance of the generator.—Show the students how to detect worn brushes, install new ones, and clean the commutator by using 00-sandpaper.

Explain to the class what over-lubrication and under-lubrication do to the bearings and other parts of the generator. Where an adjustment is possible show the class how to increase and decrease the output of the generator. Demonstrate how to adjust properly the tension on generator belt.

Checking for short circuits in the wiring.—Explain how wires with worn or frayed insulation can cause short circuits. Show how a short circuit may be detected by removing the ground wire from the post of a battery. Demonstrate how to check systematically for short circuits. Have each student do the jobs that have been demonstrated and then check the work done on the tractor assigned to him.

Discussion Topics

1. How is the generator lubricated?
2. What provision is made for generator ventilation? Why?
3. How does spacing of magneto points affect its operation?
4. When is it desirable to renew magneto breaker points?
5. Why is it undesirable to exchange electrolyte between battery cells?
6. How do extreme temperatures affect battery operation?
7. What are the advantages of having an extra set of spark plugs?
8. How do hot, medium, and cold spark plugs differ?
9. Why do most tractors use a battery ignition system?
10. Why is it inadvisable to file ignition points in a distributor?

Maintaining Carburetion and Fuel Intake Systems

Demonstrate the proper setting of the adjustments on the carburetor. Most farm tractors have three carburetor adjustments, but some are of the fixed jet type. Show the class, with the engine running at slow speed, how this speed can be changed by use of a set screw on the throttle. The idle speed jet regulates the amount of air that goes into the carburetor at that speed. Explain that on many carburetors turning in the idling screw enriches the fuel air mixture and that turning it out causes the fuel air mixture to become leaner.

With the engine running at about full throttle, the setting of the high-speed jet can be adjusted. A more nearly accurate method is to have the engine pulling on a belt or loaded with a PTO dynamometer. This high-speed jet controls the amount of fuel that enters the intake manifold. After bringing the engine to a normal operating temperature, demonstrate the adjustment of the high-speed jet by first turning in the jet until the engine begins to miss and then turning it back until the engine runs smoothly. Then, after the engine is operating smoothly, explain why the high-speed jet should then be opened a half turn. Explain that too lean a mixture will cause valve burning.

Show the students where the fuel line cleaning screens, sediment bowl, fuel tank caps, and fittings are located and how to service them as follows:

1. *Servicing the sediment bowl.*
    - a. Close the fuel tank shutoff valves.

b. Loosen the jam nut, swing the bail wire from under the bowl and remove the bowl by a twisting motion.
c. Clean the bowl and strainer.
d. Remove the sediment bowl, open fuel tank shutoff valve and check for flow. If the fuel drains sluggishly, or water and dirt are in evidence, then the strainer and fuel line must be cleaned.
e. Replace the sediment bowl and strainer. Make certain that the sediment bowl gasket is in good condition. After tightening the jam nut, inspect for leaks.

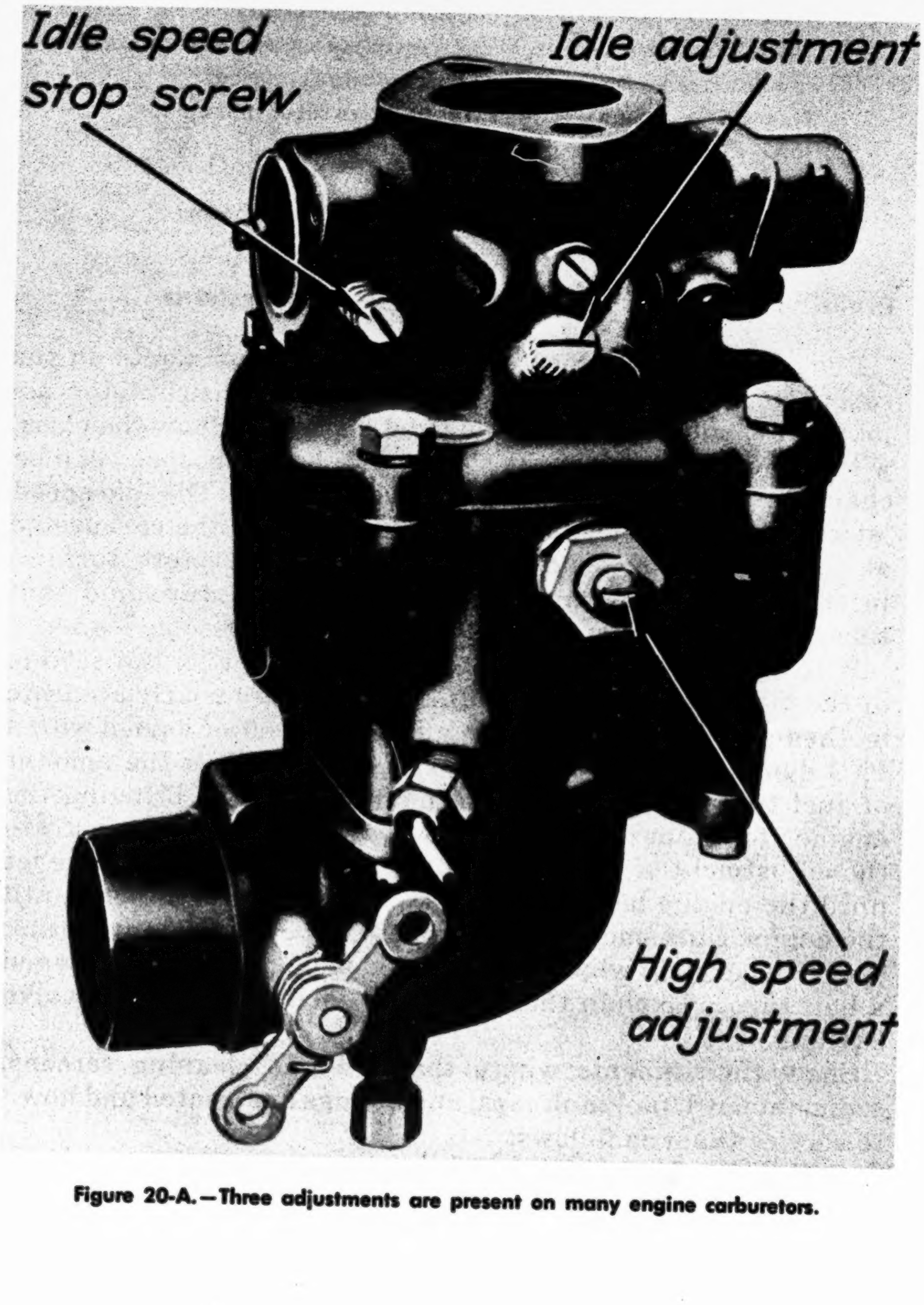


Figure 20-A.—Three adjustments are present on many engine carburetors.

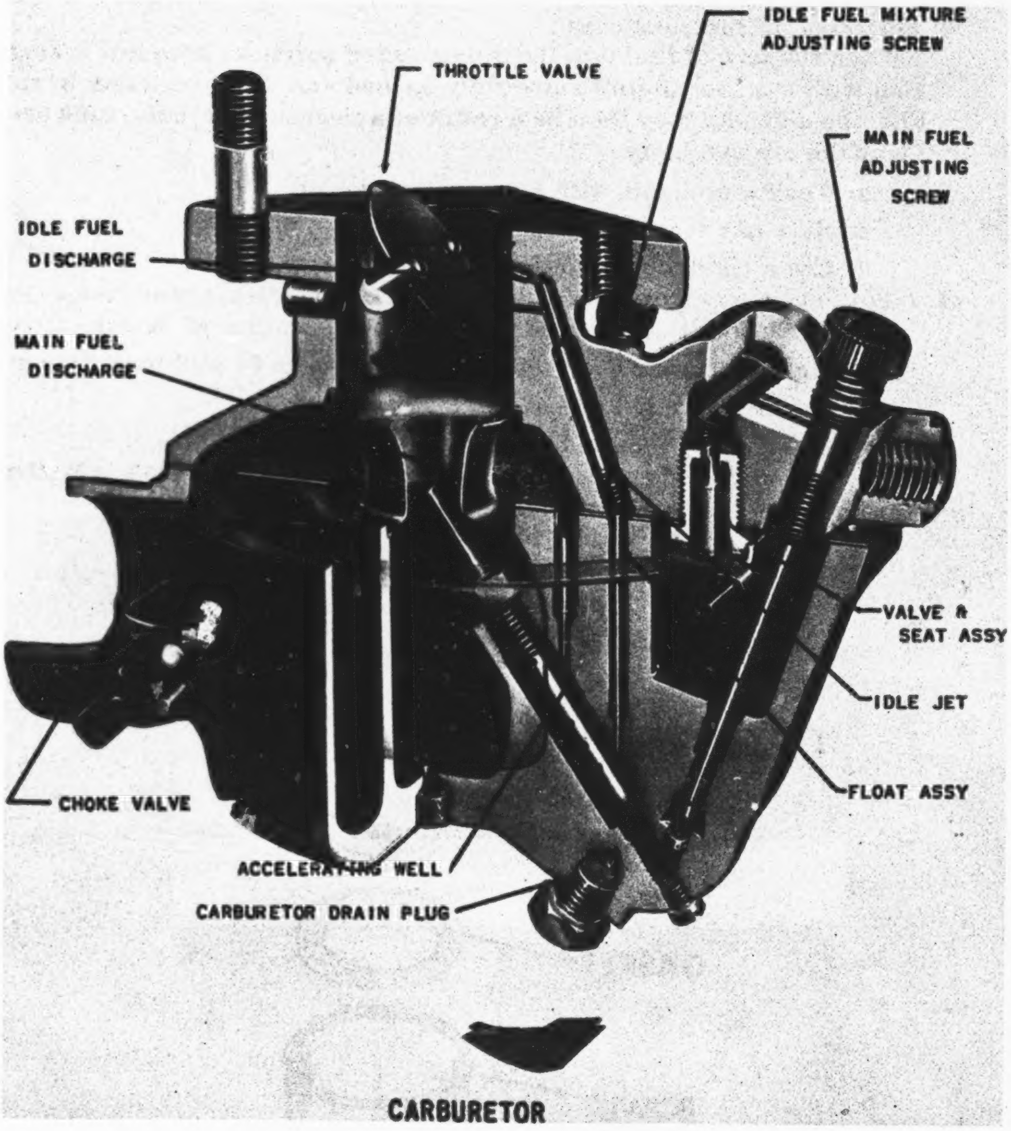

IDLE FUEL MIXTURE ADJUSTING SCREW
THROTTLE VALVE
MAIN FUEL ADJUSTING SCREW
IDLE FUEL DISCHARGE
MAIN FUEL DISCHARGE
VALVE & SEAT ASSY
IDLE JET
FLOAT ASSY
CHOKE VALVE
ACCELERATING WELL
CARBURETOR DRAIN PLUG
CARBURETOR

Figure 20-B.—Cutaway view of a modern carburetor for a tractor.

2. *Servicing the fuel line and screen*

After every 400 hours remove the fuel line screen, clean, and check the fuel flow by:

- **a. Disconnecting the fuel line from the carburetor, using an open-end wrench**
- **b. Removing the fuel line fitting which usually contains the fuel line screen**
- **c. Cleaning the screen in kerosene or fuel oil; if gum is present use a commercial gum solvent, acetone, or a mixture of one-half parts benzol and alcohol**
- **d. Checking fuel line for flow with screen removed**
- **e. Replacing with a new line if flow is sluggish due to sharp bends or dents in the line**
- **f. Installing and checking for leaks**

3. *Servicing the fuel tank caps*

When the flow of fuel into the disconnected sediment bowl line is sluggish with the fuel shutoff valve fully opened and no constriction in the line, the difficulty may then be a result of a clogged vent in the tank cap. Clean the cap as follows:

a. Wash thoroughly with kerosene or fuel oil.
b. Blow out vent with compressed air.
c. Use a metal object to clean the opening.

4. *Installing fittings, hose, and clamps connecting air cleaner and carburetor*

a. Replace the hose when there is an indication of deterioration.
b. Measure hose of correct size and length to fit well over fittings.
c. Cut hose straight across using a hack saw.
d. Clean ends of metal fittings.
e. Use any good grade of vegetable oil soap and water as a lubricant on the inside of the ends of the hose when installing.

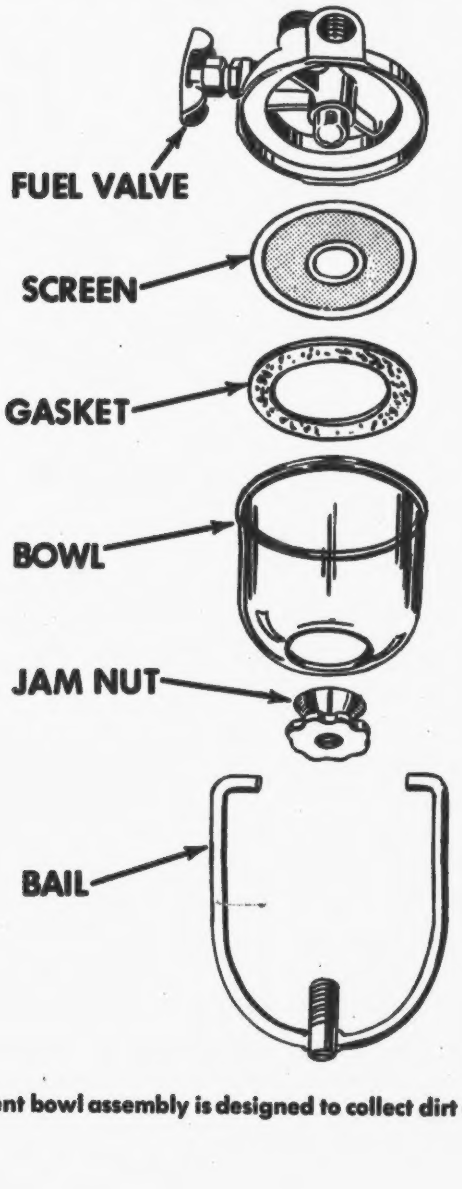


Figure 21-A.—The sediment bowl assembly is designed to collect dirt and water from the fuel.

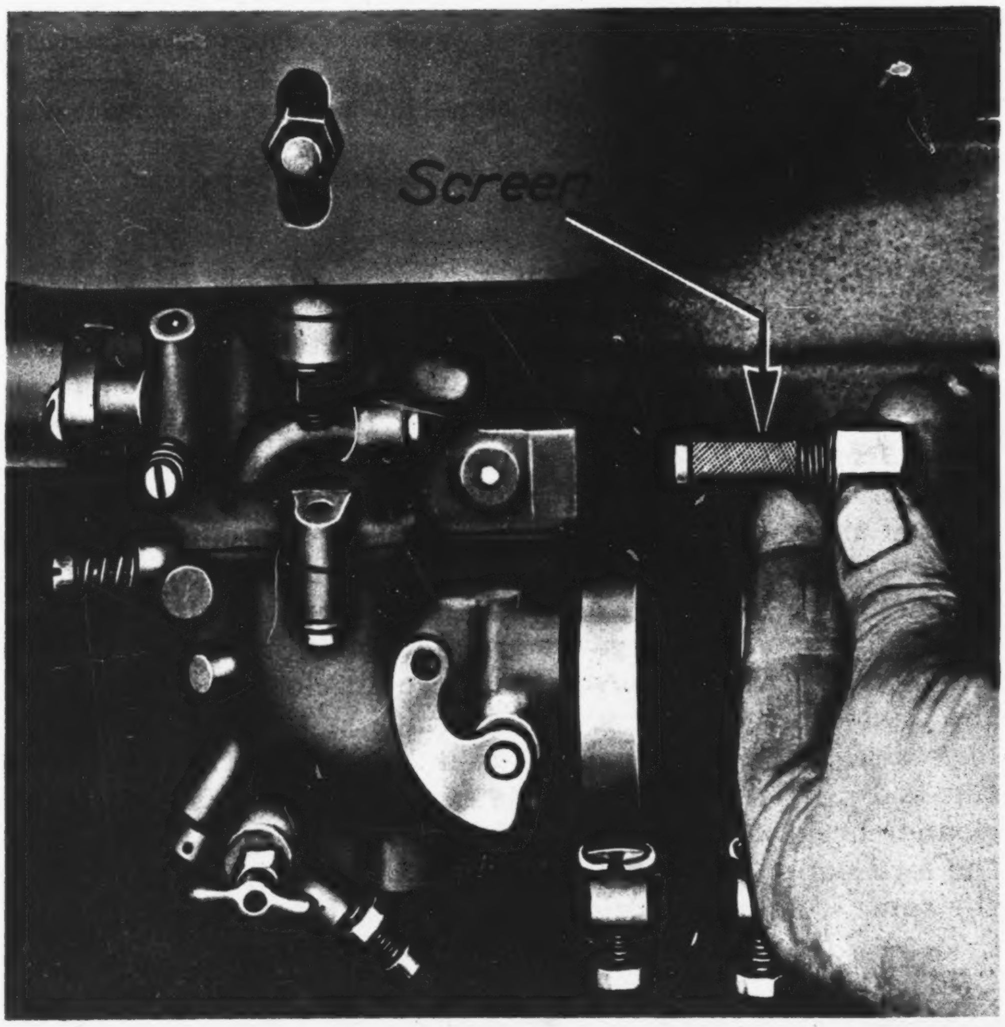


Figure 21-B.—The fuel line screen is another aid in preventing foreign material from entering the carburetor bowl.

f. Place new hose clamps, 3/16 inch to 1/4 inch back of the ends of the hose, but well ahead of the ends of the various parts to be connected.

g. Tighten snugly, by hand, the thumb screw type of clamp, then use pliers, to tighten 1½ to 2 additional turns.

Following the demonstrations have each student participate in the work after which it should be checked by the teacher.

Discussion Topics

1. What fuels are most commonly used in the farm tractor?
2. What are the advantages and disadvantages of each fuel?
3. Describe three methods of fuel storage. Give the advantages and disadvantages of each.

4. What common problems arise in cutting and fitting of tubing and hose?
5. What safety practices need to be followed in handling fuels and servicing the carburetion systems?
6. Why should high-speed jet be opened one-half turn after engine is operating smoothly?
7. Why may the valves burn when the fuel mixture is too lean?

Servicing Air-Cleaner System

The air cleaner is one of the most important attachments on the engine. The average tractor uses as much as 9,000 gallons of air per gallon of fuel in normal operation. This air must pass through the air cleaner prior to entering the carburetor.

Select a tractor on which to demonstrate the proper servicing of an air cleaner. Remove the air-cleaner cup. Examine the oil level in the cup and explain the causes for too little or too much oil. Using a putty knife, show the students how much dirt has been deposited in the cup. Clean the cup in a safe solvent, then remove the entire air-cleaner body. Show the students the amount of dirt that has accumulated in the air stack. Clean the entire body in a safe solvent after which the body of the air cleaner is reinstalled. Remove the air cleaner breather cap and also clean it in a safe solvent. Fill the air-cleaner cup with new engine oil to correct level, using the same weight of lubricant that is used in the crankcase, or

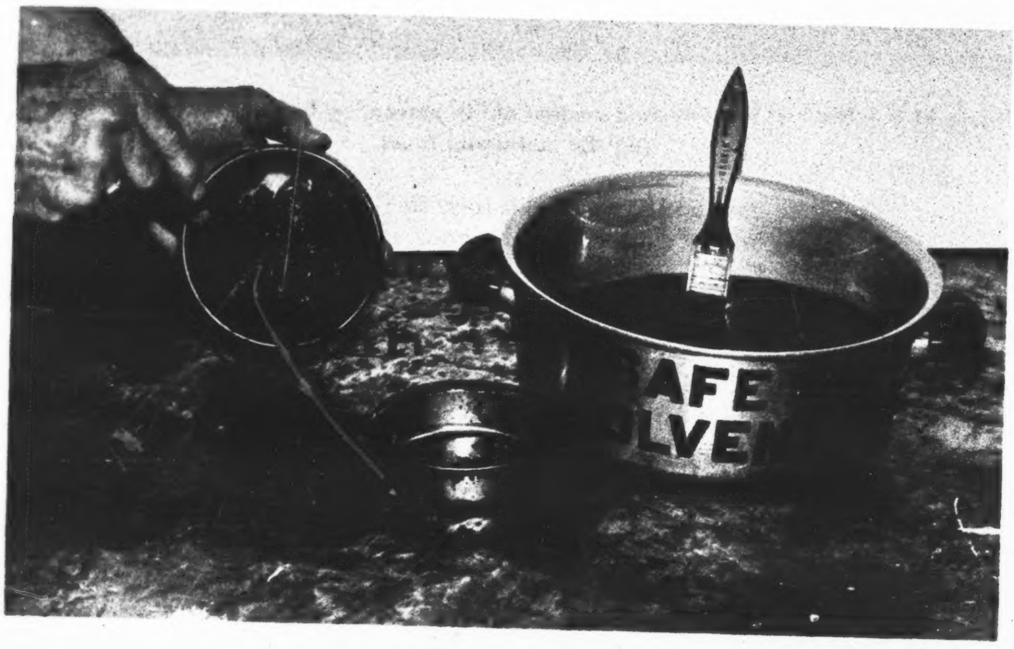


Figure 22-A.—Servicing an oil bath air cleaner.

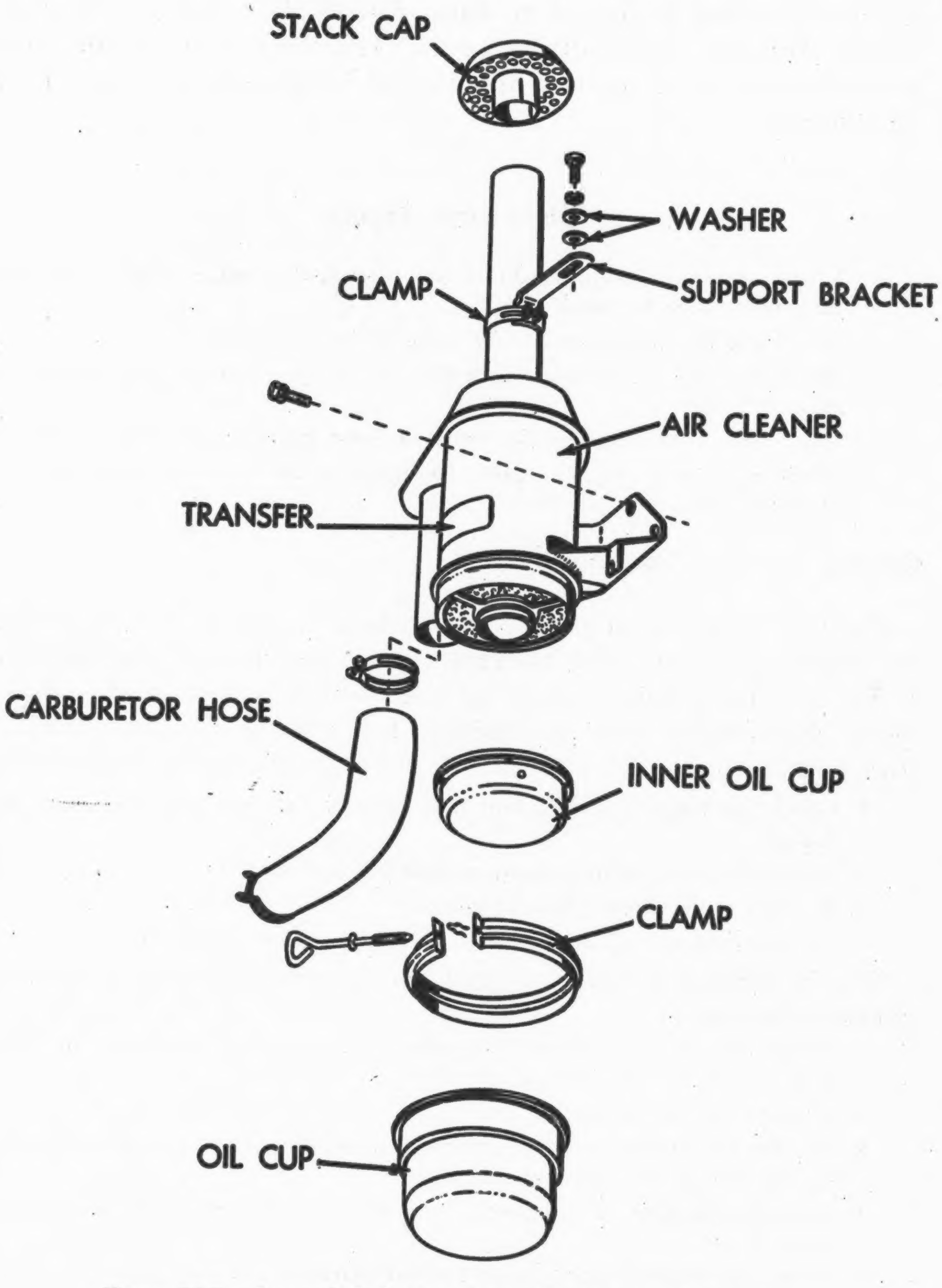

STACK CAP
WASHER
CLAMP
SUPPORT BRACKET
AIR CLEANER
TRANSFER
CARBURETOR HOSE
INNER OIL CUP
CLAMP
OIL CUP

Figure 22-B.—An exploded view of an oil bath type air cleaner.

as otherwise recommended by the manufacturer. Explain that it is necessary to remove and clean the cup after every 10 hours of operation and the air cleaner body twice a year. Under extremely dusty conditions clean the cup more frequently. Inspect the air lines between the air cleaner and carburetor to assure that there are no leaks. Each student using a tractor assigned to him should clean an air cleaner. Under difficult air conditions many tractor operators also use an auxiliary air cleaner which should be cleaned as frequently as the cup.

Discussion Topics

1. What are the several kinds of air cleaners? Under what conditions may each type be used?
2. What are the purposes of the auxiliary air cleaner?
3. What may be the causes when dirt is not found in the cup of the air cleaner?
4. Why remove the air-cleaner body at least twice a year for servicing?
5. What harm may result if using too light or too heavy an oil in the air-cleaner cup?

Caring for the Cooling System

Explain to the students that the two methods of cooling the tractor engine are the thermosiphon and forced circulation. Point out the different parts of the cooling system and explain their functions. The procedure for caring for the water-pump type of forced circulation cooling system is as follows:

1. Clean the pump housing and hose with a safe solvent and check for leaks.
2. Check the nuts, clamps, or cap screws for tightness.
3. Replace any gasket or hose that leaks.
4. Lubricate the pump as recommended in the operator's manual.

The following procedure will aid in maintaining a cooling system thermostat:

1. Clean with a safe solvent the housing or hose that encloses the thermostat and check for leaks.
2. Remove the thermostat.
3. Inspect the thermostat for sticking, wear, corrosion, or the accumulation of lime or other foreign material.
4. Clean thermostat, if necessary, in a solution of warm water and washing soda.
5. Check the opening and closing temperatures of the thermostat by using a water bucket, hot water, and a thermometer.
6. Replace thermostat with a new one if there is evidence of damage.
7. Replace the thermostat.

Coolants.—Use clean soft water in the cooling system but in freezing weather add antifreeze as recommended in the operator's manual. Procedure for filling the cooling system with antifreeze.

1. Drain and flush the system with clean water. Sometimes it is necessary to use a cleaning agent.
2. Check the hose for leaks and collapsed portions. Replace as needed.
3. Close drain openings and tighten all hose connections before adding antifreeze.

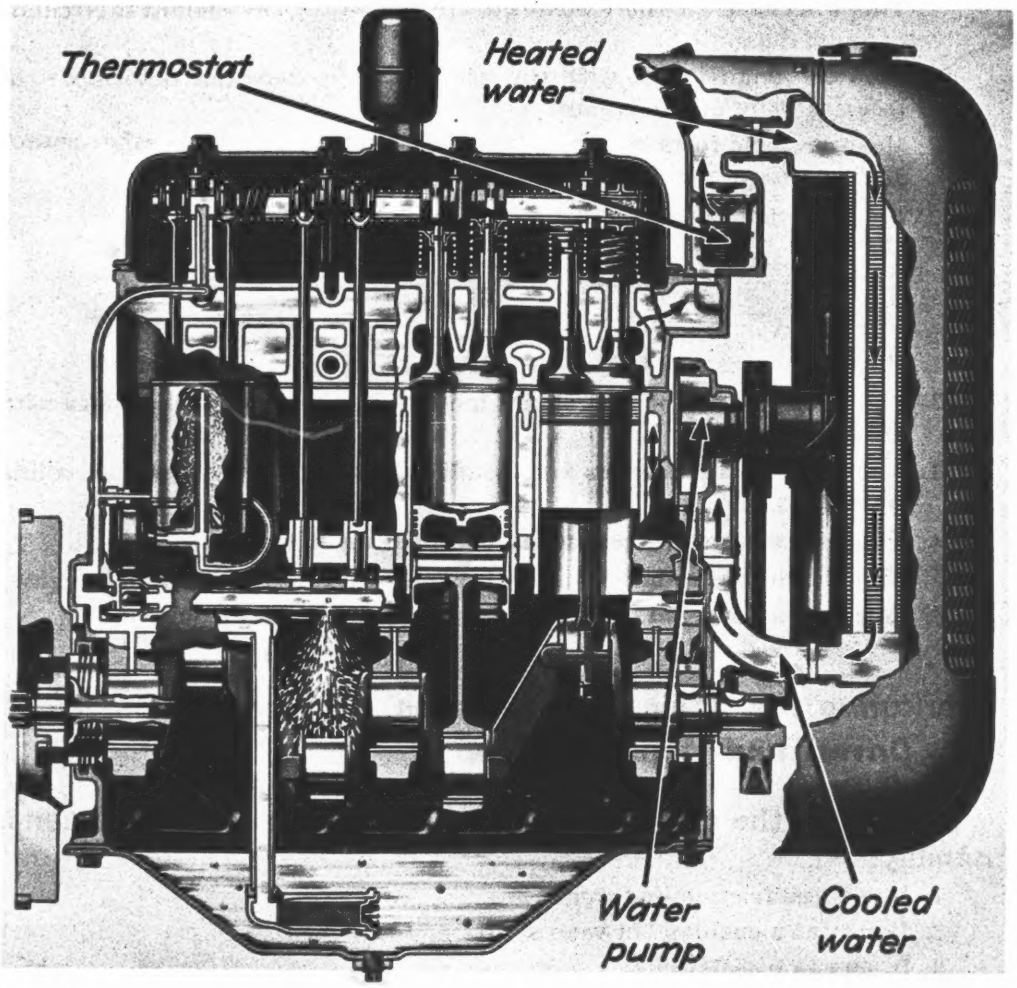

Thermostat
Heated water
Water pump
Cooled water

Figure 23-A.—The forced circulation cooling system requires the use of a pump and thermostat.

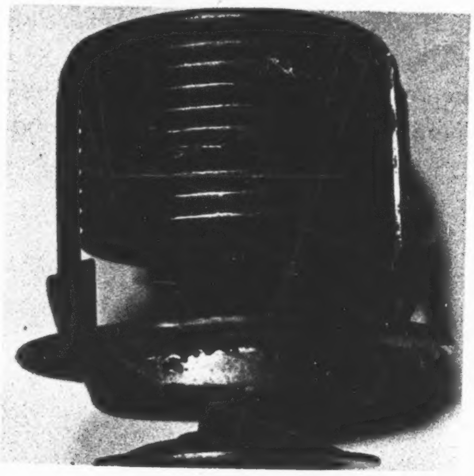


Figure 23-B.—A thermostat with a damaged bellows.

4. Add antifreeze and then warm engine to the operating temperature. This will cause the theromostat to open, allowing the coolant to circulate through the system.
5. Stop the engine and, with the use of the hydrometer, determine the freezing point of the coolant.
6. Make periodic tests of the coolant throughout the cold weather season and maintain adequate protection.

Have each student do the jobs demonstrated.

Discussion Topics

1. Why is it necessary that clean, soft water be used as a coolant?
2. How is circulation of the coolant induced in a system not equipped with a water pump?
3. What are the advantages and disadvantages of a pressure-type cooling system?
4. What are some of the causes of overheating of the engine?
5. Why should the radiator cap be removed cautiously from a hot engine?
6. How may a damaged fan belt or fan affect cooling of the engine?

Lubricating the Engine, Transmission, Differential, and Final Drives, and Adjusting Tappets

Explain to the class that engine oil has five main functions, namely:

1. It reduces friction and wear
2. It acts as a cushion between shafts and bearings
3. It acts as a coolant
4. It helps to keep the interior of the engine clean
5. It seals power between piston rings and cylinder wall

The teacher may ask a lubrication specialist from an oil company to explain to the class the different grades and types of engine oil.

Engine.—Most manufacturers of tractors recommend the changing of engine oil at designated intervals. Demonstrate this job by: (1) warming the engine to normal operating tem-

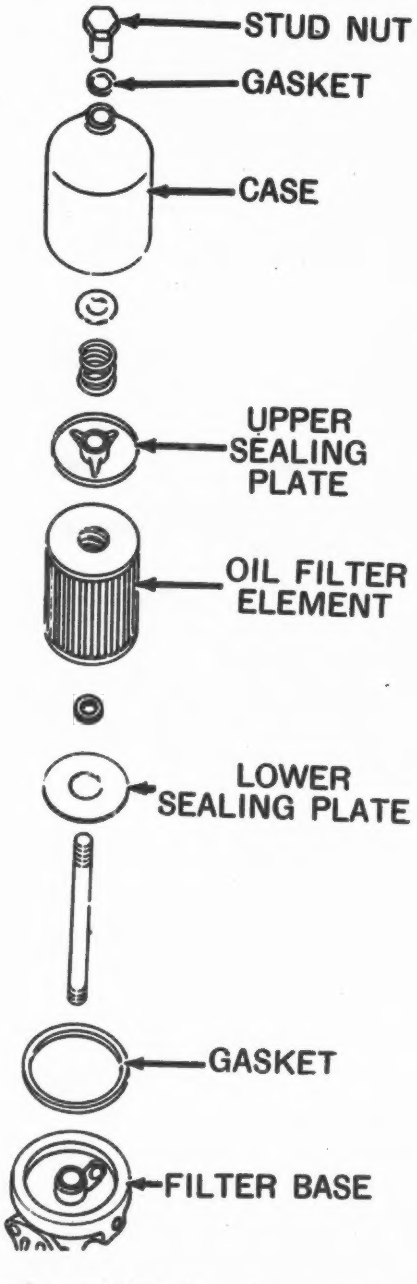

STUD NUT
GASKET
CASE
UPPER SEALING PLATE
OIL FILTER ELEMENT
LOWER SEALING PLATE
GASKET
FILTER BASE

Figure 24-A.—An exploded view of a common type oil filter.

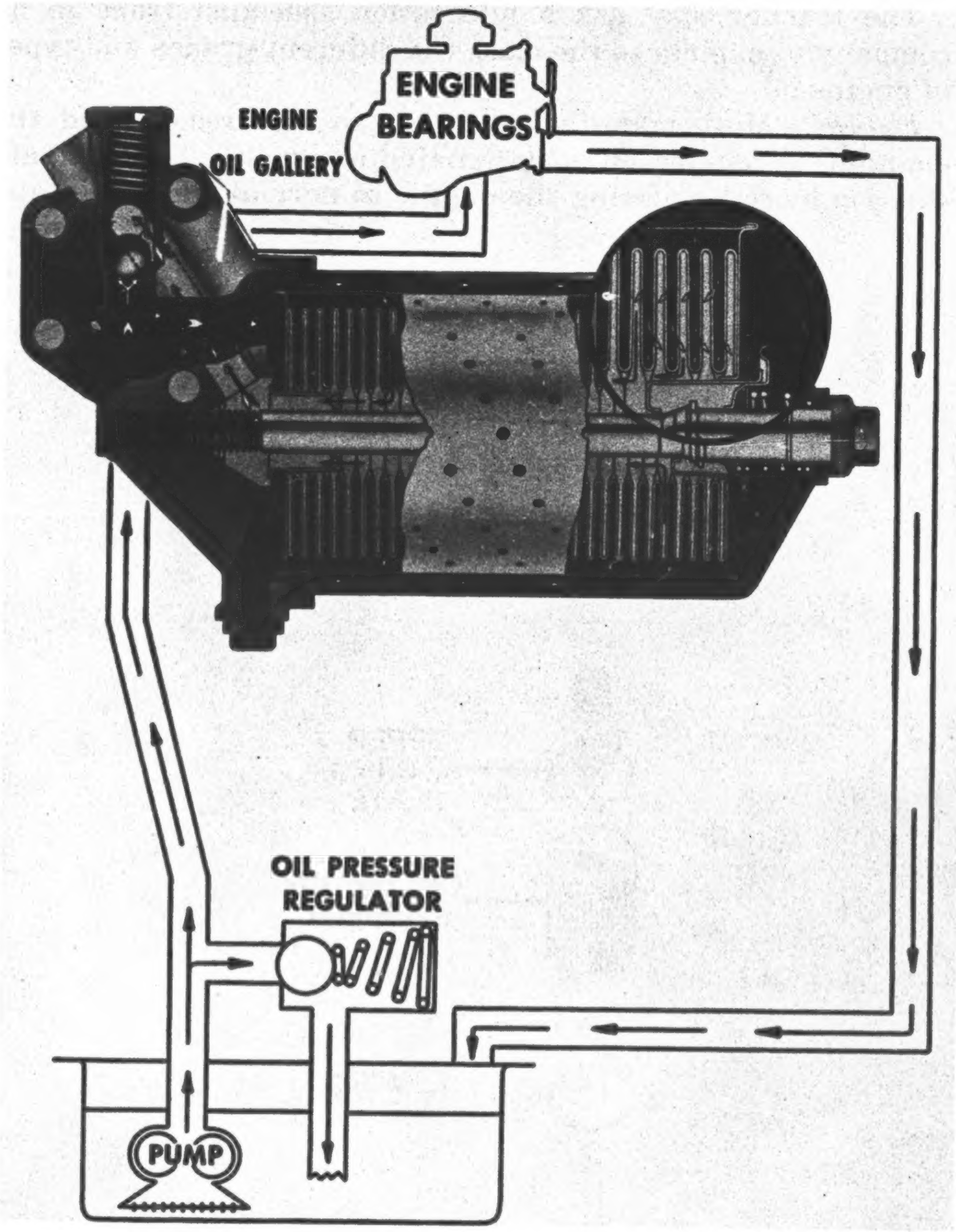

ENGINE BEARINGS
ENGINE OIL GALLERY
OIL PRESSURE REGULATOR
PUMP

Figure 24-B.—A cutaway view of an oil filter that uses a replaceable element.

perature; (2) draining the used oil from the crankcase; (3) removing the oil filter cartridge; and (4) draining the oil filter base.

Flush the engine if using a nondetergent oil in the crankcase. Remove the spark plugs and take a compression reading before and after flushing the engine. Flush the engine as recommended by the manufacturer. After the crankcase is

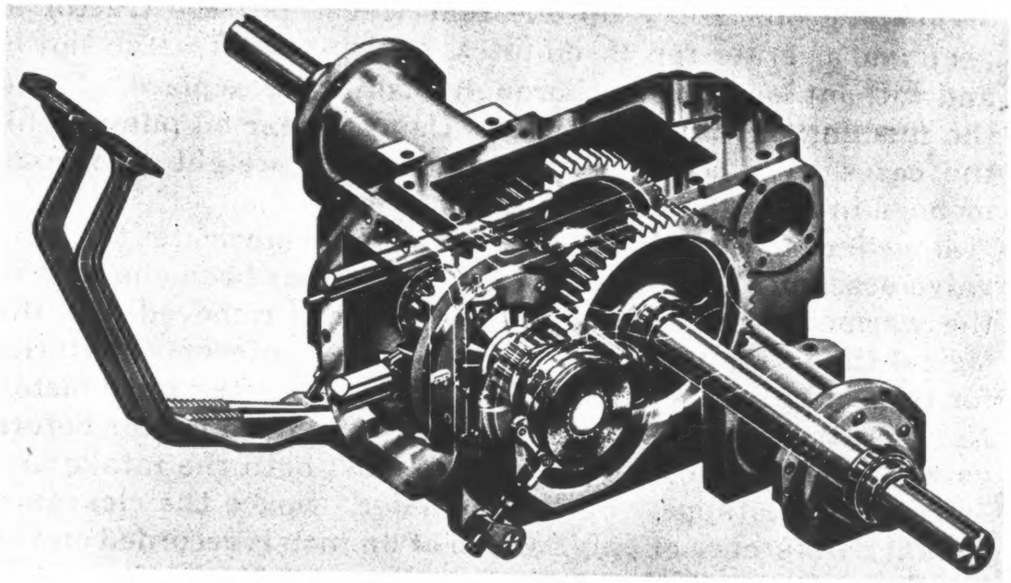


Figure 25.—Exposed view of brakes, brake pedals, differential, bearings and gears. The gear train is lubricated by oil bath.

drained, fill it with flushing oil to the proper level. Warm the engine by operating it at a fast idle for approximately 30 minutes with the shutter closed or lay a blanket over the radiator.

Drain the flushing oil, install the new oil filter cartridge, and fill the crankcase with new engine oil of seasonal weight. Some oils have additives to prevent rust and foaming. Start the engine and inspect for oil leaks. The use of a detergent type lubricant may lessen the need for flushing to remove dirt and sludge formations.

Transmission, differential, and final drives.—Change the oil in these units at regular intervals as stated in the operator's manual.

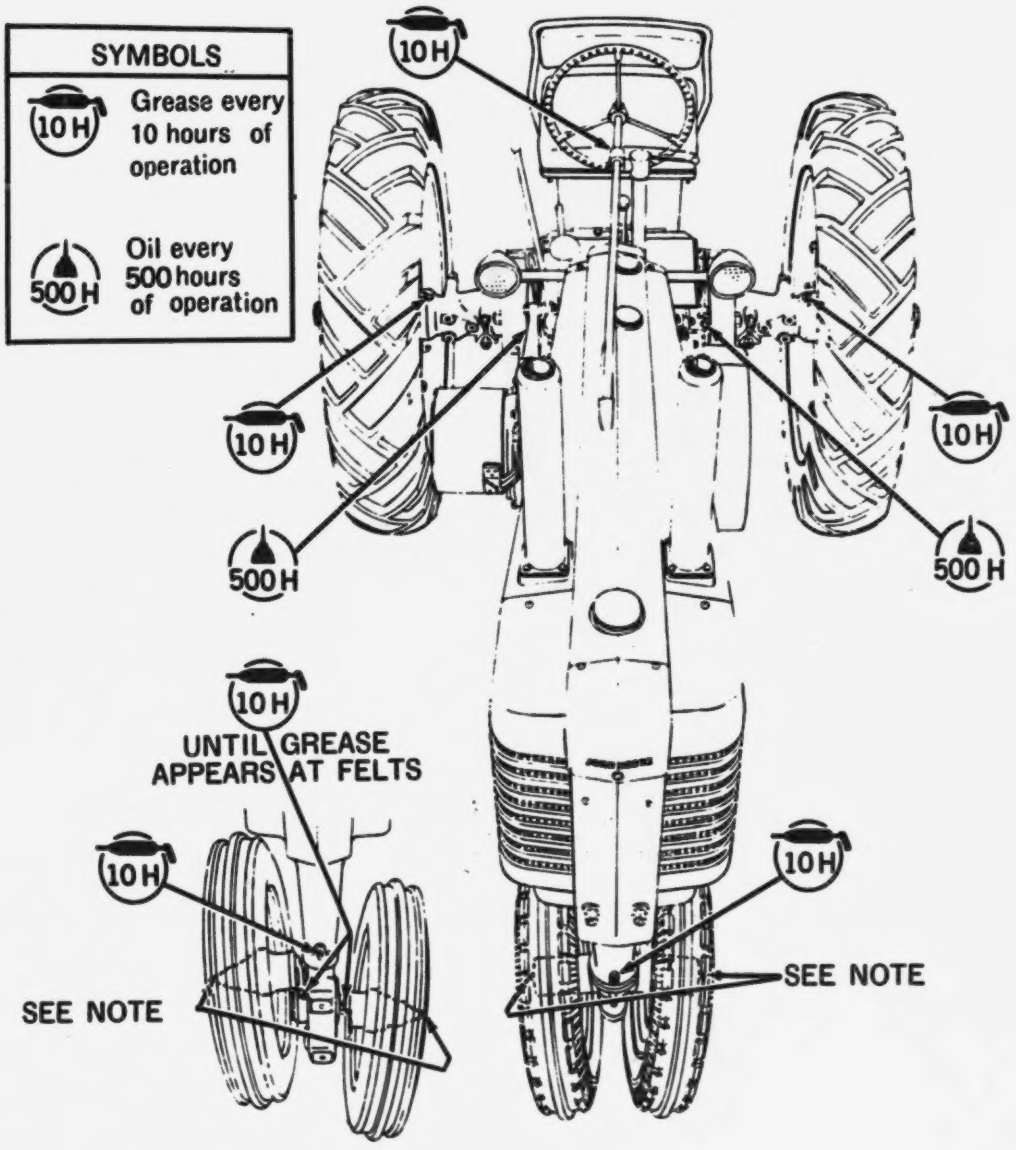
Transmission lubricants become contaminated because: (1) metal particles flake off the gears; (2) steel chips are knocked off the gears when they are clashed in shifting; (3) fine bits of metal accumulate from normal wear of the gear teeth; and (4) changing seasons and temperature, together with the heating and cooling of the tractor, cause condensation and gradual accumulation of water in the transmission, differential, and final-drive cases.

Demonstrate the proper way to clean the transmission, differential, and final-drive cases as a means for keeping wear at a minimum by: (1) draining the transmission, differential, and final drives; and (2) refilling the cases with either kerosene or flushing oil. Block up one rear wheel, put the tractor in gear and operate for 15 minutes, or drive the tractor slowly and without load until a thorough flushing takes place. Drain the flushing oil from the cases. Using a gear oil pump, refill the cases with new lubricant of seasonal weight as recommended in operator's manual.

Adjusting tappets.—Oil from the crankcase lubricates the total valve assembly. When the crankcase oil has been changed in the warmed engine and the valve cover is removed it is the logical time to adjust the tappets. Check reference material for correct valve tappet spacing. Turn the crank until piston No. 1 on the compression stroke is on top dead center before valve tappet setting takes place. Adjust both the intake and exhaust valve tappets on this cylinder. Space the clearance so that a difference of only 0.001th of an inch is recorded on the the feeler gage—if the correct spacing is 0.014th of an inch, a 0.014th leaf of a thickness gage will pass between the valve and valve tappet, but a 0.015th of an inch leaf will not pass through without forcing. After the valves on cylinder No. 1 are adjusted, move the pistons on the other cylinders to top dead center on the compression stroke and adjust the tappets in like manner for the rest of the cylinders. On overhead valves set the check nut with a box wrench. On an L-head engine it is necessary to use a pair of tappet wrenches. Each student should perform all the engine lubrication jobs and adjustments. Carefully check each student's work to assure correct procedure.

Discussion Topics

1. What precautions should be taken in the use, storage, and handling of lubricants to prevent contamination?
2. What are the most common causes of sludge formation?
3. Does lubricating oil wear out? Explain.
4. What is the purpose of an oil filter? How often change the cartridge? What are the different kinds of oil-filtering systems and how does each function?
5. What is a detergent oil? An additive? Purposes of each?
6. Why will some oils darken in color rapidly when in use?
7. What may cause used engine oil to look "milky" in color?
8. Can gear lubricants carry foreign material?
9. What are the dangers of using contaminated transmission lubricants?
10. What are the dangers to tractors in towing?
11. What happens to a ball or roller bearing in a transmission when it has no lubricant?


SYMBOLS
10 H Grease every 10 hours of operation
500 H Oil every 500 hours of operation
10 H
10 H
10 H
500 H
500 H
10 H
UNTIL GREASE APPEARS AT FELTS
10 H
10 H
SEE NOTE
SEE NOTE

Note Twice yearly disassemble front wheel bearings, clean thoroughly, and repack with wheel bearing grease.

Under wet conditions, grease front wheels every 10 hours or oftener.

Figure 26.—Detailed lubrication information for the several parts of a tractor.

General Lubrication

Lubricate the chassis at least every 10 hours of operation in accordance with an approved procedure. Demonstrate such general lubrication of the farm tractor as follows:

1. Select a tractor for the demonstration. Tie numbered cards to the specific lubrication points. The card should include the frequency of service and specify lubricant to be used.
2. Locate all points requiring lubrication on the tractor.

Packing front wheel bearings.—The following tools and supplies are needed for demonstrating this job: A can of general-purpose grease, wash tray filled with a safe solvent, combination pliers, 12″ adjustable-end wrench, cotter keys, hub-cap wrench, paint brush, diagonal pliers, clean cloths, hydraulic jack, and steel horse.

Place the tractor so that all students can see the demonstration. Jack up a front wheel and place the steel horse under the axle. Remove the hub cap. Using the diagonal pliers, remove the cotter pin. Unscrew the spindle nut and remove the wheel from the spindle. Service the outer bearings by washing in a safe solvent, using a paint brush. Dry the bearings with a clean cloth or by using compressed air without spinning the bearing. Working in a dust-free atmosphere put a small amount of general-purpose grease in the palm of the left hand. Hold the bearing in right hand and by taking small bites of the grease in the palm of the left hand, pack the bearing. Service the inner bearing in a like manner, but if is tight on the spindle, place the can of solvent under it and wash until clean. Dry the bearing with a clean cloth. Place grease on the outside of the bearing. Wrap a clean cloth around the inner bearing and twist the two ends of the cloth using the fingers of the left hand to press the grease into the bearing. Remove the cloth.

Clean the hub of the wheel with a safe solvent. Install a new dust seal. Replace the wheel and avoid putting any grease in the hub or hub cap. Tighten the spindle nut until the wheel binds slightly, then turn back the nut one castellation. Replace the cotter key and hub cap.

Discussion Topics

1. What are the purposes of lubricants?
2. Why is it necessary to lubricate some points on the tractor after every 10 hours of operation whereas other parts require lubrication only once a week or annually?

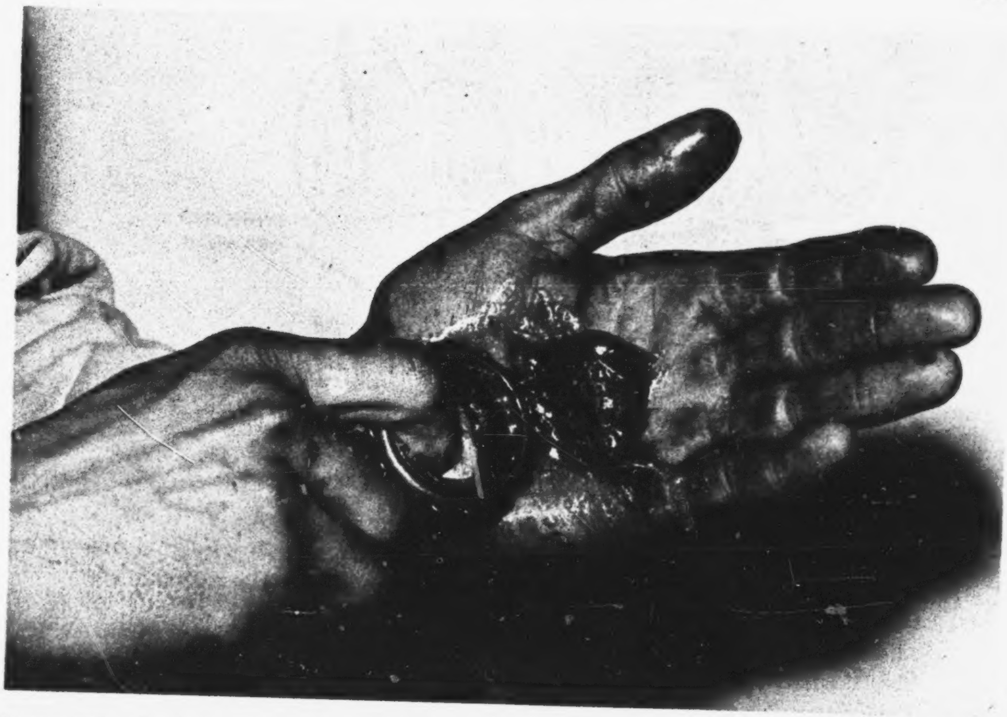


Figure 27.—Packing grease into a wheel bearing. A mechanical packer is available.

3. Why is grease rather than oil used in many fittings?
4. How do seasons of the year affect the selection of lubricants?
5. Where are special types of lubricants used?
6. On what type of bearings may new grease be used to force out the old dirt-laden grease?
7. What is a sealed bearing? How lubricate?

Maintaining Power Applications

These applications involve several different items and for each provide a separate demonstration. Some of the features to include in the demonstration for each item follow:

Clutch:

1. Use tractors with foot- and hand-operated clutches. The pulley brake is presented with the clutch.
2. Compare instructions in the operator's manual with the actual amount of free travel of pedal to observe proper clearance between release levers and release bearing on automotive-type clutch.
3. Lubricate the automotive-type clutch bearing, if recommended.
4. Make adjustments of pulley brake on overcenter clutch.
5. Adjust pulley brake for easy shifting. First adjust too tight and then too loose, so as to observe the effects of each.

Brakes:

1. Jack up both hind wheels of tractor. Adjust one wheel brake until bands contact the drums with sufficient pressure to lock the wheel when

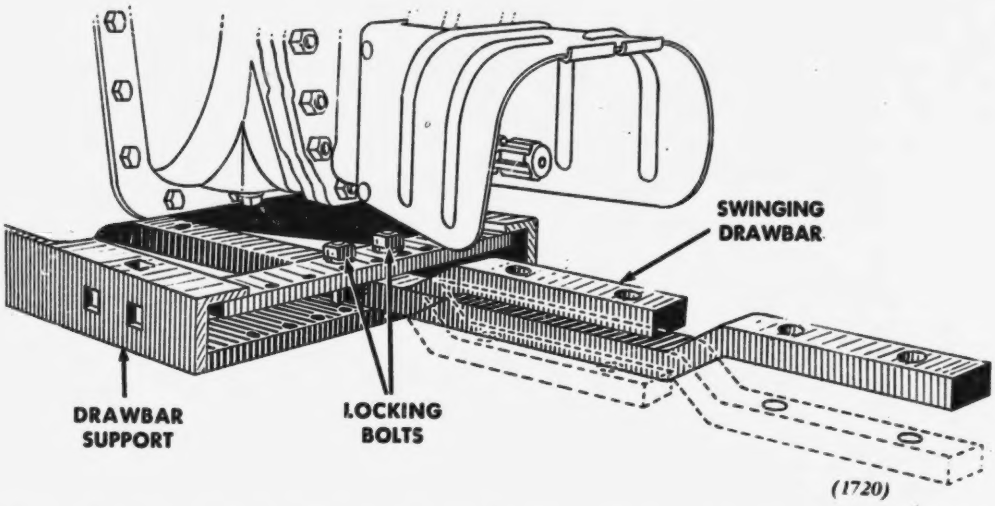


Figure 28.—One type of drawbar with horizontal, vertical, and longitudinal adjustments that may be either locked into position or allowed to swing.

the foot pedal is depressed. Repeat same process for the other wheel. Adjust until both wheels lock simultaneously under the same pedal depression. Upon release of foot brakes both wheels should operate freely.

2. Adjust each wheel brake so that it may be used for effective turning. Caution: slow down when using brake as a turning aid to lessen danger to both operator and equipment.
3. Replace brake shoes before linings are worn sufficiently to score the drums. Readjust brakes when making such replacement.

Drawbar:

1. Make the three drawbar adjustments—longitudinal, horizontal, and vertical.
2. Show the effect and purposes of all three drawbar adjustments upon the drawn implements.
3. Attach implements to drawbar to show the American Society of Agricultural Engineers' standards for hitching.

Belt Pulley:

1. Measure pulley width and diameter and explain general design.
2. Demonstrate the formula (SxD=sxd) for belt speed and required diameter of driven machine pulley.

   S=speed of tractor engine pulley.
   D=diameter of tractor engine pulley.
   s=speed of driven machine pulley.
   d=diameter of driven machine pulley.
3. Demonstrate pulley alinement, belt tension, and adjustment of V-belt sheaves.
4. Stress safety with belt-driven machines.

Further information on belt pulleys is presented under "Maintaining Power Applications on Stationary Units."

Power Take-Off:

1. Discuss general design of the power take-off.
2. Compare the power take-off on tractors being worked upon with standards set by the ASAE as to location, speed, size, and other details.
3. Show need for disengaging power take-off before dismounting from tractor.
4. Stress safety precautions, such as stopping tractor before servicing drawn equipment and having all shields in place.

Power Lift and Hydraulic System:

1. Explain general design and uses made of hydraulic system.
2. Discuss the need for periodic servicing.
3. Demonstrate the use of power lifts on both the power unit and the operated implement.

Transmission, Differential, and Final Drives:

1. Trace the flow of power in transmission in all speeds—forward and reverse.
2. Demonstrate differential action by holding one rear wheel stationary and turning the other rear wheel.
3. Locate lubrication devices built into case and bearing quills.
4. Check for final drive axle bearing wear by wedging a bar under one rear wheel at a time.
5. Demonstrate width adjustment of rear wheels for different kinds of work.

Discussion Topics

1. What is the relative importance of proper clutch adjustment from the standpoint of safety, performance, and cost of upkeep?
2. What factors influence clutch effectiveness?
3. What results may occur from improper brake adjustments on wheels, pulleys, and tracks?
4. How can time, money, and effort be saved by proper drawbar hitching?
5. What are the ASAE hitching standards?
6. What is the effect on belts when sheaves are not alined and adjusted?
7. How is tension regulated on V-belts?
8. What are the advantages and disadvantages of the high-speed power take-off?
9. What are the advantages of alining the power take-off to the driven machine?
10. Why is it essential to keep the power lift fluids clean?
11. In what ways are the transmission, differential, and final drives a part of power application?
12. What is the main purpose of the transmission?
13. What is the function of the differential?
14. What is the effect of a loose bearing in the final drive?

Winterizing

In giving instruction on winterizing a tractor for use in cold climates it may be necessary to repeat some demonstrations. The following demonstrations should be given:

1. Drain the crankcase and refill with engine oil of seasonal weight.
2. Drain the radiator and block and refill with antifreeze solution.
3. Protect tires by having them filled with recommended antifreeze solution.
4. Service air cleaner.
5. Drain the transmission, final drives, and differential, and refill with proper weight of lubricant.
6. Remove, clean, adjust, and reinstall spark plugs.

Storage.— A shelter is extremely important for storing a tractor. Before storing the tractor for winter or long periods of non-use give it a thorough cleaning and paint any bare spots. Also show how to do the following tasks:

1. Remove spark plugs and pour a few tablespoons of engine oil into each cylinder.
2. Drain fuel system, including tank, carburetor, and fuel lines. Clean carburetor. Leave drains open.
3. Drain and flush the radiator. Leave drains open.
4. Lubricate the entire tractor and apply rust preventive as needed.
5. Remove battery and store it in a dry place where the temperature is above freezing.
6. Block up the tractor to remove weight from the tires.

Attach warning tags to steering wheel and starter button, stating, among other things, that before tractor is used, crankcase must be drained, an oil filter cartridge installed, crankcase filled to correct level with oil, drain openings closed, and the engine turned over several revolutions with starter or crank.

Discussion Topics

1. What is the difference between a summer weight and a winter weight lubricating oil? What is a multi-purpose lubricating oil?
2. What are the advantages of a permanent type antifreeze solution?
3. What are the advantages and disadvantages of placing antifreeze in tires?
4. Does a light weight oil lubricate an engine as well as a heavy one?
5. What is the best procedure to follow when starting a tractor in cold weather?
6. When is it recommended to use gasoline instead of fuel oil during extremely cold weather?

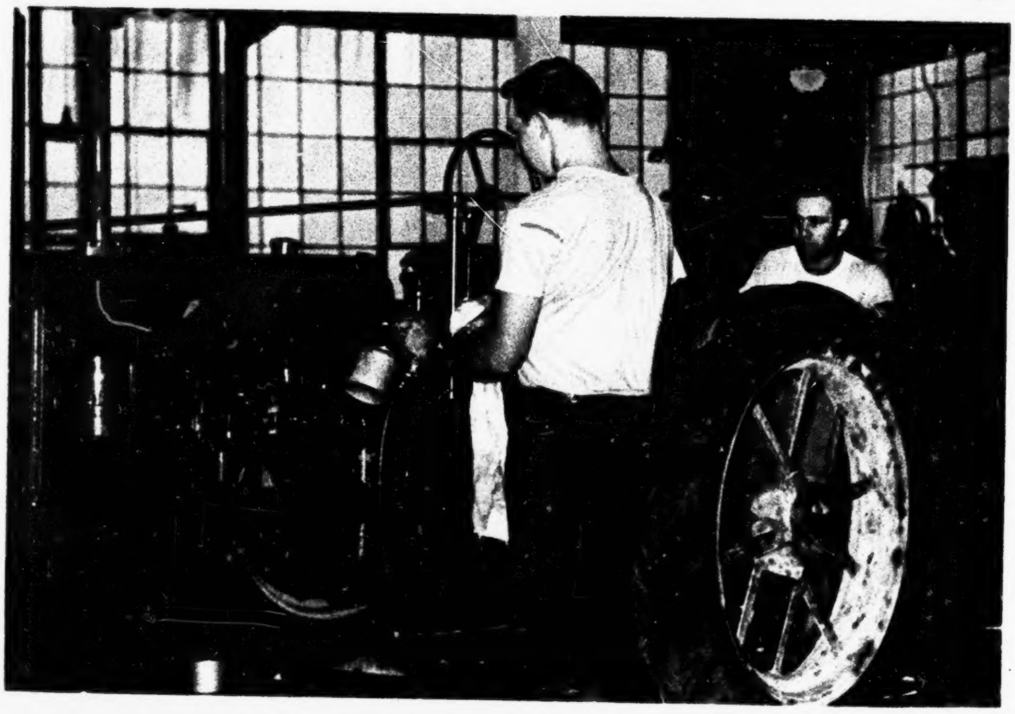


Figure 29.—Spray painting a tractor. A special paint room is recommended.

7. Why is tractor lubricated when stored for a long period of time and again when removed from storage?
8. What precautions should be taken when painting a tractor?
9. What procedure would you follow when removing a tractor from winter storage?

Locating and Correcting Tractor Troubles

An alert operator recognizes the warning signs of trouble ahead and arranges for necessary correction. Much of this can be accomplished by noting unusual sounds and performance and by observing the gages for signs of abnormality. Once a trouble is recognized, the tractor engine should be stopped until the problem is corrected. Trouble may result from a single cause or a combination of causes. Determine the trouble through an orderly elimination process. Those of a major nature may require the attention of a trained serviceman.

Through demonstrations and use of references determine the possible causes and remedies of tractor troubles. The following list includes some recognizable trouble areas which may develop in a farm tractor.

Engine hard to start or will not start.

Engine operates irregularly or knocks.

Lack of power on belt and drawbar.
Engine overheats or runs too cold.
No oil pressure or pressure is too low.
Oil pressure too high.
Oil dilution.
Using too much oil.
Using too much fuel.
Generator does not charge.
Starter does not operate.
Hydraulic system inoperative.

Discussion Topics

1. Why use an orderly systematic procedure to locate troubles?
2. What troubles are more likely to occur when a stored tractor is not protected from weather?
3. How trace trouble originating in the electrical system?
4. What are common carburetion troubles that develop when a tractor has been improperly prepared for storage?
5. When daily maintenance services are not provided, what troubles are most likely to develop?
6. What procedure is best to follow when a generator fails to charge?
7. How is a magneto timed to the engine?
8. Do fuel suppliers provide blends best suited to seasonal use?
9. How can oil dilution be prevented?

Storing and Handling Fuels

The type of fuel used, such as gasoline, LP-Gas, and diesel fuels, is often the factor for determining the storage system to be installed. It is essential to know the local and State regulations regarding the storage and handling of tractor fuels. The National Fire Protection Association has established standards and codes pertaining to fuels. The American Petroleum Institute and the National Safety Council also have lists of standards that pertain to safety and other factors relating to fuel storage and handling. The main factors to consider in fuel storage are: (1) protection of quality, (2) safety, (3) convenience, and (4) cost. To maintain the quality of a stored fuel protection must be given to prevent evaporation, contamination from dirt and moisture, condensation, and gum deposits. Above-ground storage should be at least 40 feet from the nearest building. Underground storage is safer, but is more costly to install and

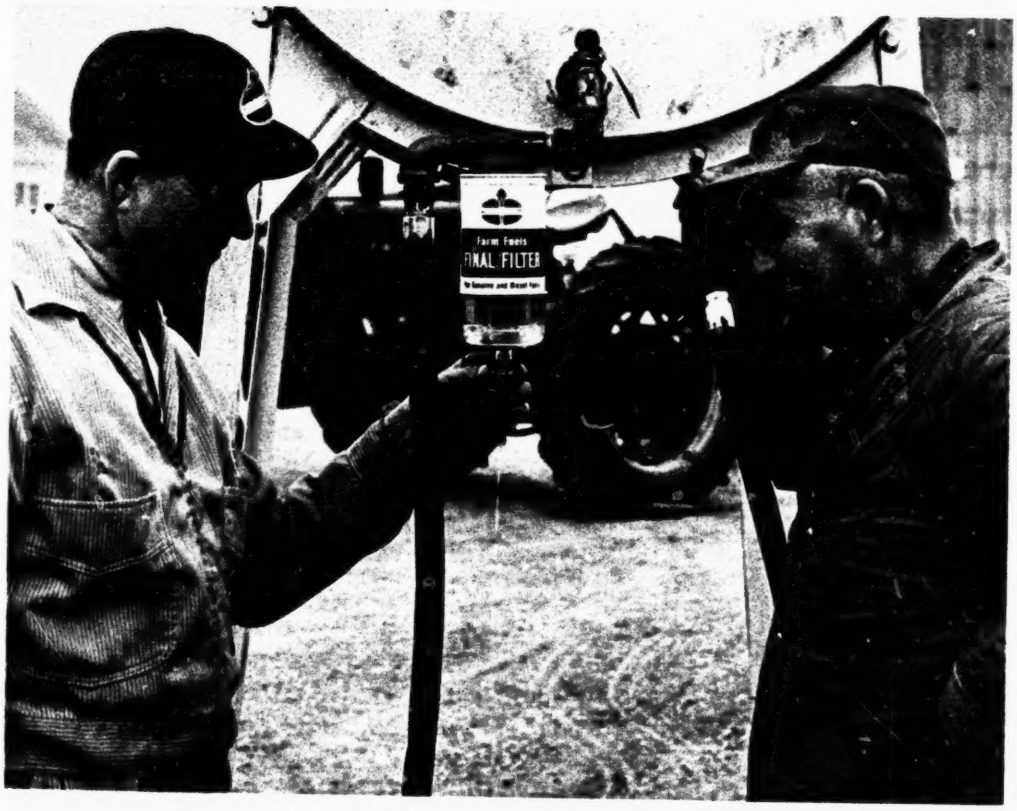


Figure 30.—Overhead fuel storage with final filter in line.

maintain. Leaks in underground storage are difficult to detect. Locate storage close to the point of greatest use. The LP-Gas storage tank should be at least 50 feet from buildings and not closer than 20 feet from other fuel storage. Use approved color coding on handling equipment and above-ground storage for the fuel used. Also see "Maintaining Carburetion and Fuel Intake Systems" as presented earlier in this chapter.

Discussion Topics

1. What are the advantages and disadvantages of underground fuel storage? Above-ground storage?
2. What are the common causes of contamination in stored fuels? How remove water and sediment from above-ground storage tanks? Below-ground tanks?
3. What safety precautions need to be followed in handling fuels?
4. How does color coding further assure safety?
5. How does LP-Gas fuel differ from other fuels as to handling and storage?
6. What information is provided on the storage tank nameplate for LP-Gas? Liquid fuels?

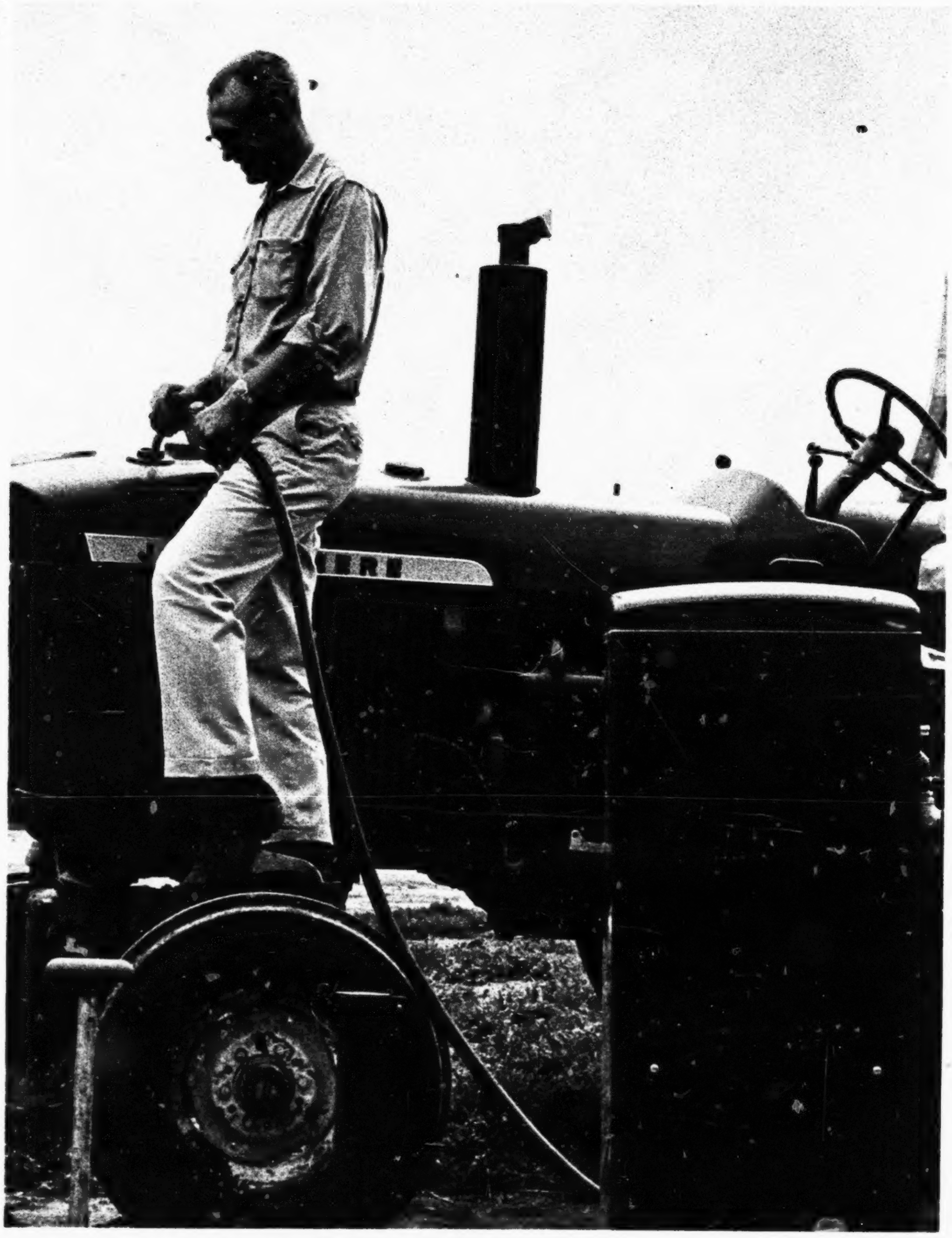


Figure 31.—Underground fuel storage with final filter in line.

Stationary Engines

The popularity of the small engine has been enhanced materially since much equipment has become motorized, for example, lawn mowers, garden cultivators, grain elevators, seed cleaners, and pumps. The general principles given for

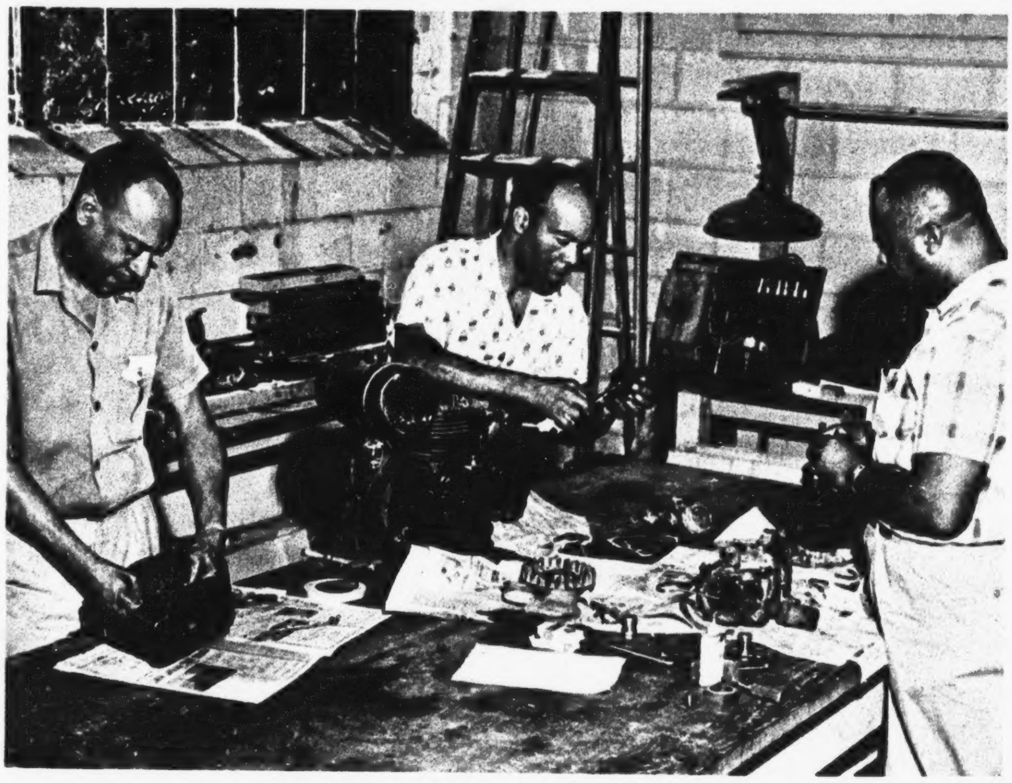


Figure 32.—Students in an adult farmer class servicing small engines.

the care and maintenance of the farm tractor apply to the stationary engine. The name plate on many stationary engines provides essential information with which the operator should be acquainted.

Selecting and Using.—In selecting an engine it is more desirable to obtain one that has a surplus of power rather than endeavor to use speed to gain needed power. Such engines may be portable on trucks or skids and others must be bolted in place. Select the mounting most suitable for convenience and the job to be performed. Regardless of the job to be performed it is essential for the engine to be held rigidly in position to the machine operated.

Maintaining Power Applications on Stationary Units.—These involve belts and pulleys, clutch, and governor. Belts are of the flat and V-type. There are many designs of the V-type and it is imperative that the belt selected fits the pulley groove pattern. The V-type belt is often used in multiples and when there is but little distance between the drive and driven pulleys. Idlers are of particular importance where pulleys are of small diameter in order to increase belt contact on the drive pulley. Flat belts are often used when there is greater distance be-

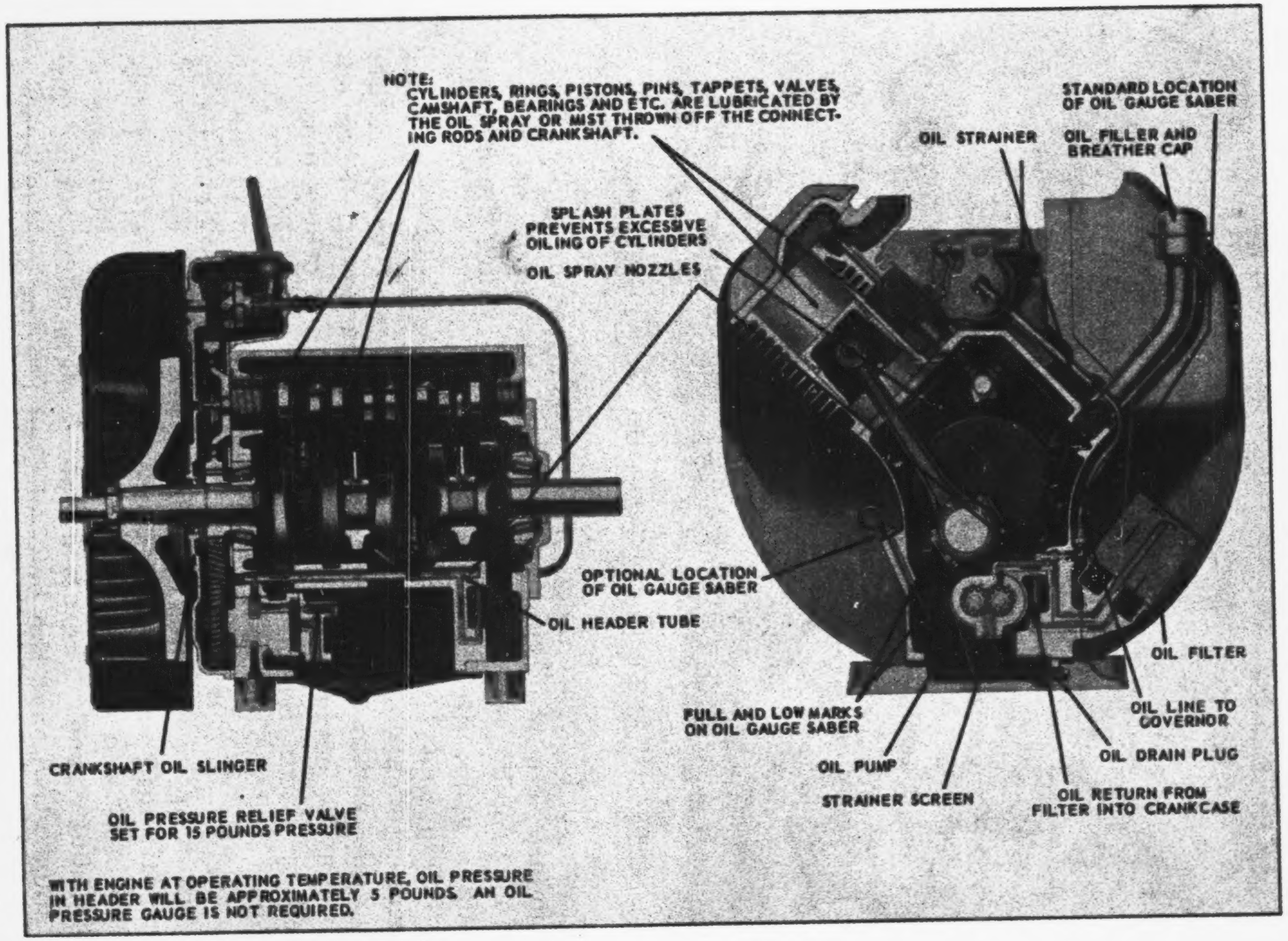

NOTE:
CYLINDERS, RINGS, PISTONS, PINS, TAPPETS, VALVES, CAMSHAFT, BEARINGS AND ETC. ARE LUBRICATED BY THE OIL SPRAY OR MIST THROWN OFF THE CONNECTING RODS AND CRANKSHAFT.
STANDARD LOCATION OF OIL GAUGE SABER
OIL STRAINER
OIL FILLER AND BREATHER CAP
SPLASH PLATES PREVENTS EXCESSIVE OILING OF CYLINDERS
OIL SPRAY NOZZLES
OPTIONAL LOCATION OF OIL GAUGE SABER
OIL HEADER TUBE
OIL FILTER
FULL AND LOW MARKS ON OIL GAUGE SABER
OIL LINE TO GOVERNOR
OIL DRAIN PLUG
OIL PUMP
STRAINER SCREEN
OIL RETURN FROM FILTER INTO CRANKCASE
CRANKSHAFT OIL SLINGER
OIL PRESSURE RELIEF VALVE SET FOR 15 POUNDS PRESSURE
WITH ENGINE AT OPERATING TEMPERATURE, OIL PRESSURE IN HEADER WILL BE APPROXIMATELY 5 POUNDS. AN OIL PRESSURE GAUGE IS NOT REQUIRED.

Figure 33.—Stationary engine showing lubrication system and engine parts.

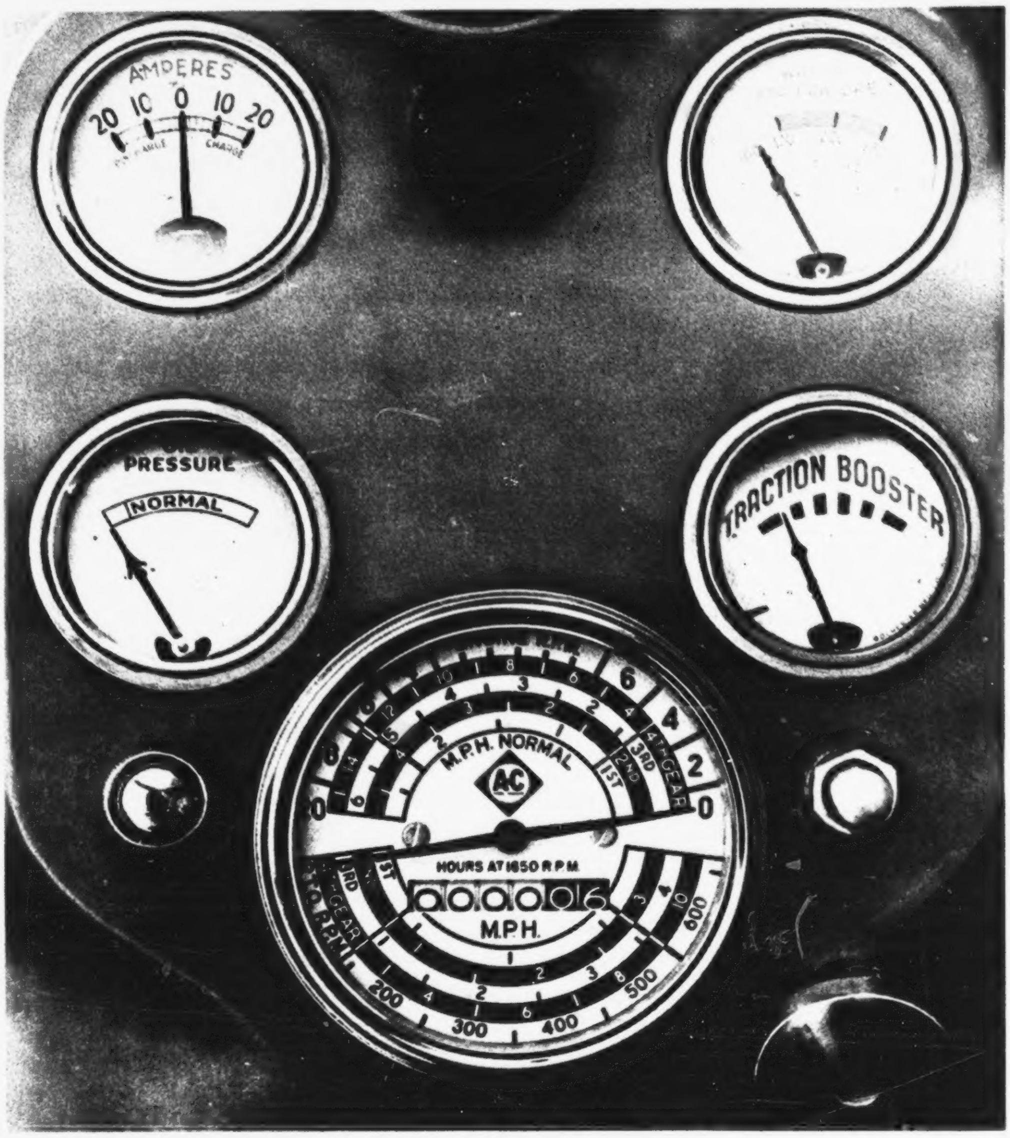

AMPERES
20 10 0 10 20
DISCHARGE
CHARGE
PRESSURE
NORMAL
TRACTION BOOSTER
M.P.H. NORMAL
AC
1ST
2ND
3RD
4TH GEAR
HOURS AT 1650 R.P.M.
M.P.H.
200
300
400
500
600

Figure 34.—The motorized truck as well as tractors and stationary engines have gages to aid in operation.

tween the pulleys. To increase the pulley contact with a flat belt, use an idler or employ a wider belt. It is not recommended that pulley dressing serve as a substitute for needed belt pulley contact.

The *clutch* has much to do with the smooth operation of the driven machine. Care needs to be taken to avoid excessive clutch slippage even under the heaviest load. Clutches are available in dry or wet types and some of them are adjustable.

The purpose of the *governor* is to automatically control the maximum speed of operation as recommended by the manufacturer. The RPM of the engine should be checked periodically with a tachometer. Likewise check the RPM of the driven machine to determine if there is belt slippage or pulley of improper diameter. Also see "Maintaining Power Applications" as presented earlier in this chapter.

Discussion Topics

1. To replace an electric motor with an engine, how would you determine the needed horsepower?
2. What procedure would you use to aline the drive and driven pulleys?
3. What problems may occur when the pulleys are not alined?
4. Why is it essential to have the engine and driven machine solidly in position?
5. How increase tension on flat belts? V-type belts?
6. What may result if too much tension is applied to the belt?
7. What are causes of burned clutch facings?
8. When a clutch chatters what may be the cause?
9. What causes a governor to fail to regulate speed as set by the manufacturer?
10. What information is given on an engine name plate?

Transportation Units

The motorized truck, for other than personal travel, is the main transportation unit on the farm although other power units are sometimes used for this purpose. This unit will pertain only to the truck since the tractor has already been presented. Many of the statements pertaining to the tractor and stationary engine also apply to the truck.

Selection and Maintenance.—There is a size and type of truck to meet the needs of most any farming situation. The most commonly used truck is known as the pick-up. The demands of many modern farms require more than one truck in order to operate effectively and efficiently. The latest census reveals that 2,177,080 farms, or 58 percent of the total, have trucks. These farms have 2,833,763 trucks, or an average of 1.3 units per farm. Some of the items to consider in selecting a truck include amount of on-farm and off-farm use, whether to purchase a new or used unit, type of truck bed, capacity, type of fuel to be used, loading and unloading devices, availability of service for the kind selected, availability of financing, and trade-in advantages.

The per ton and per mile cost of operation for a truck is materially affected by the service and maintenance provided.

Servicing and maintaining a truck should be performed in a well-planned and systematic manner to assure trouble-free and efficient operation. To provide such service requires essential equipment and clean facilities. Records should be maintained on all servicing which includes miles of operation, dates of service, amount of lubricants and fuels used, kinds of repairs, and cost of parts.

Discussion Topics

1. How do miles of operation and model of a truck affect trade-in value?
2. What factors should be considered as to size and type of truck to purchase?
3. When is it desirable to have more than one truck?
4. What are multi-purpose truck beds?
5. How do season of year and operation affect servicing?
6. How do load and speed of operation affect cost of maintenance?
7. What types of hydraulic lifts are used on trucks?

OTHER FARM MACHINES

Kinds of Farm Machines, by Function

Farm machines are divided, by function, into the following five divisions:

Preparing the Seedbed.—The following are some of the machines used in seedbed preparation—moldboard plows, disk plows, rotary plows, listers or middlebreakers, harrows, cultivators, chisels or sub-soilers, rod weeders, rollers, packers, levelers.

Planting Crops and Fertilizing.—To perform these tasks many machines are used such as: broadcast seeders; grain drills; corn planters; cotton planters; beet, bean, and vegetable seed planters; potato planters; plant setting machines; manure spreaders; lime spreaders; commerical plant food distributors.

Cultivating Crops.—Crops are cultivated by many methods requiring machines such as: cultivators; rotary hoes; pencil point, rod, flame, and chemical weeders; plant blockers; rotary choppers; and orchard and truck-garden tillage machines.

Harvesting and Handling Crops.—Such machines are designed for specific types of harvesting or crop handling. Harvesting machines include those for hay, small grain, corn, fiber, root crop, and special crops. Those for handling crops include

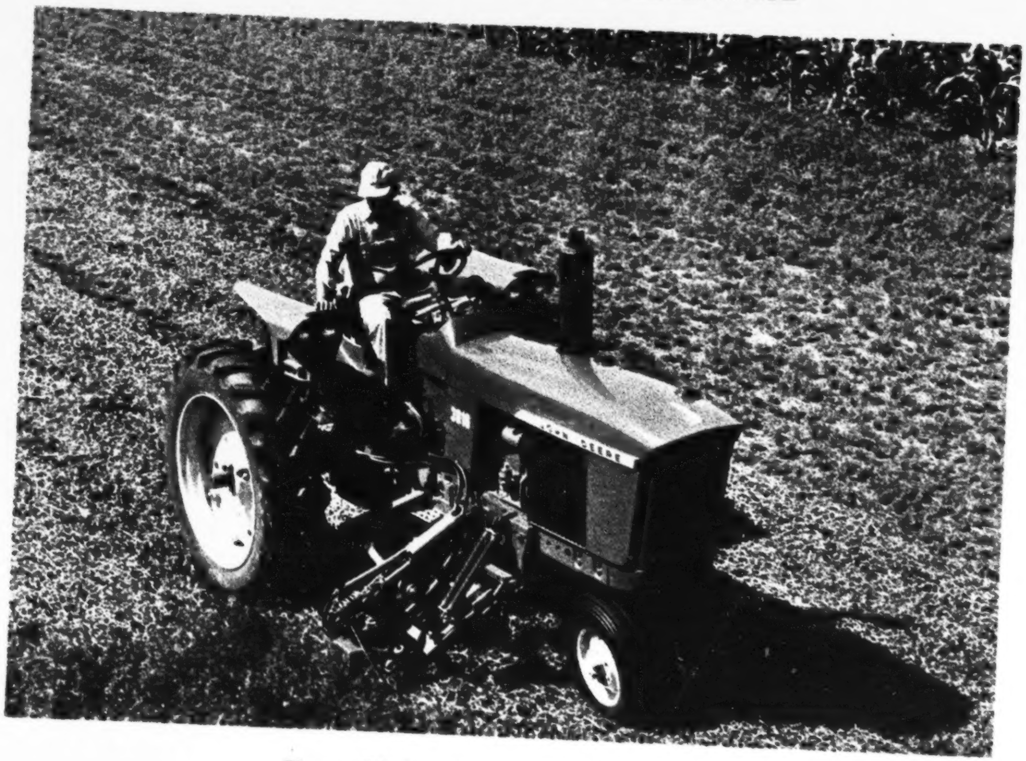


Figure 35-A.—Center-mounted mower.

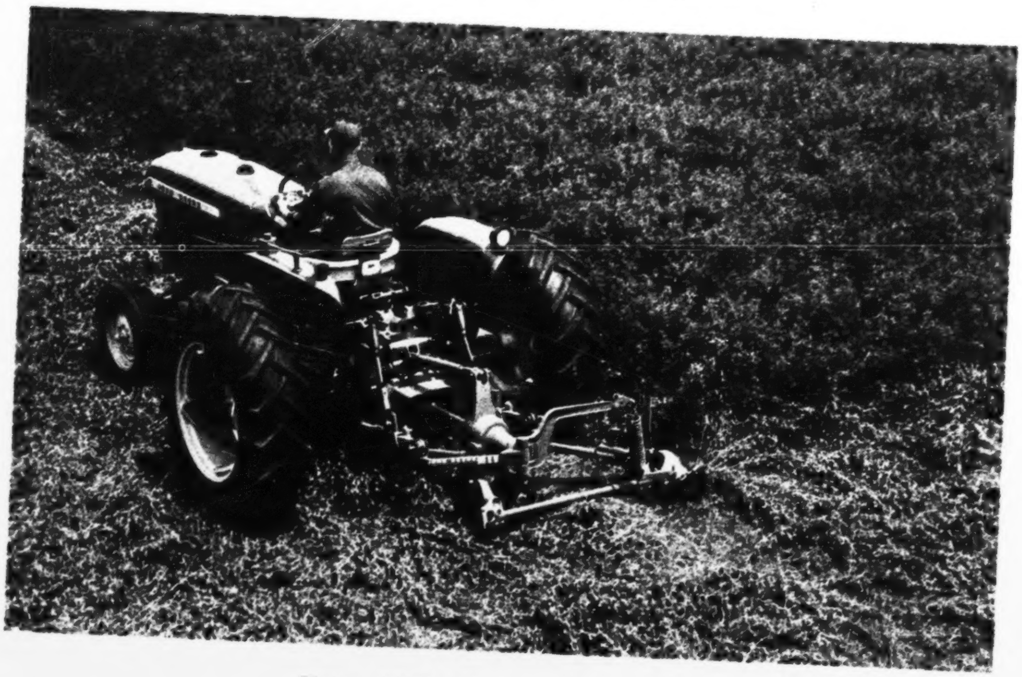


Figure 35-B.—Rear-mounted mower.

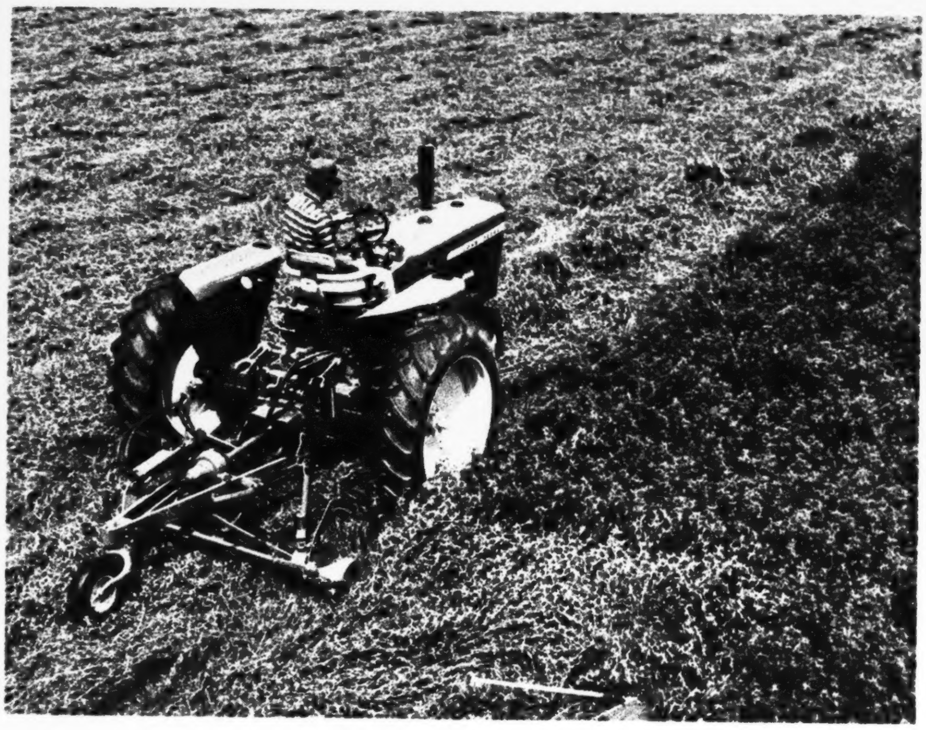


Figure 35-C.—Semi-mounted mower.

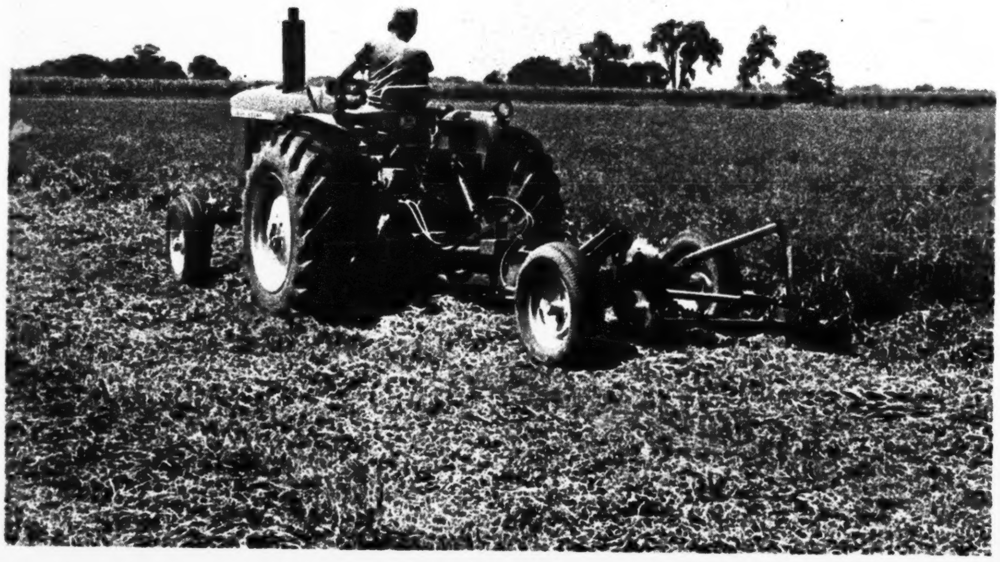


Figure 35-D.—Trail behind mower.

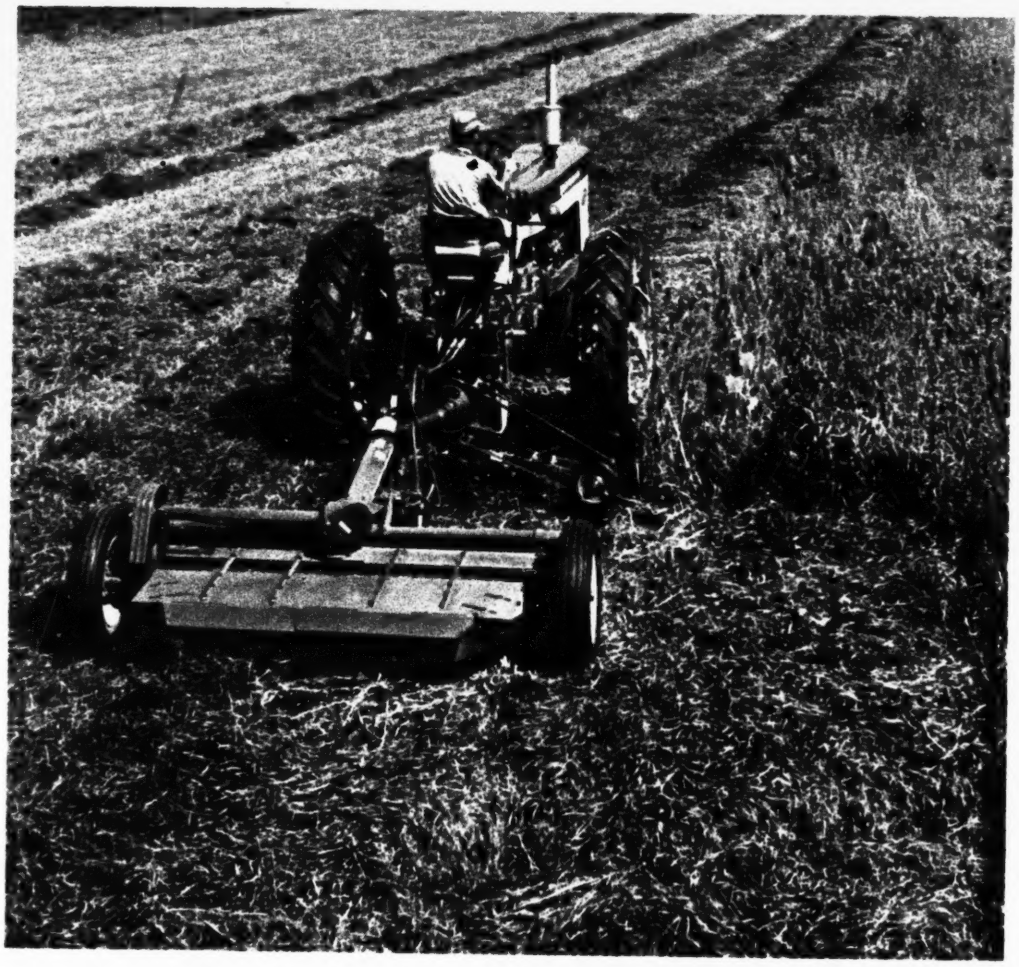


Figure 36.—A pitmanless mower and a hay conditioner.

corn shellers; forage, vegetable, fruit, and nut harvesters; balers; crop loaders; and hullers.

General Service Machines and Equipment.—As the title indicates such equipment fulfills many purposes and includes machines for feed processing, seed cleaning, seed grading, crop protection, driers for forage and grain, dairy barn and dairy product equipment, elevators, terracers, and pumps.

MOWERS

The mower is one of the more important farm machines because of its general use in all sections of the country and with many different kinds of forage. This machine is in the functional division of harvesting and handling crops and is the only one to be presented under the heading "Other Farm Machines." Steps in the method of instruction for this hay-cutting machine with which the teacher must be familiar would be similar to that listed for "Instructional Procedures," Chapter II.

Selecting and Identifying Mowers and Mower Parts

The selection of field machines involves adjusting the factors of power availability, implement performance, labor production, timeliness, and costs, so as to assure that an optimum economic return results. These factors need to be considered when selecting mowers as a part of good farm management practices.

Preparation for the Teacher

Nearly all mowers are basically the same as far as the cutting mechanism is concerned—a knife moves back and forth over ledger plates to shear off plants as the mower moves through the field. The main differences lie in the means of driving the knife and the type of vehicle or frame used to carry the cutting mechanism.

A *tractor-drawn mower* has a complete self-contained frame for carrying the cutting mechanism because the mower trails behind the tractor. The rear-mounted mower is carried on the tractor, but the trail-behind is pulled. Today all power mowers are operated through the power take-off. If the mower is chain driven, a slip clutch is included in the power line to protect the cutting and drive mechanisms.

Power-driven mowers can be further classified according to method of mounting to the tractor, as semi-mounted, rear-mounted, trail-behind, and center-mounted.

The front end of a *semi-mounted mower* is attached to the tractor drawbar. The balance of the mower is carried on one or two wheels, depending on the design of mower. If the mower cutterbar is raised and lowered hydraulically, a hydraulic remote cylinder replaces the lifting lever. An important feature of semi-mounted and trail-behind mowers is that most of them are designed to fit many tractors. The trail-behind mower differs in that most of the weight is carried on the mower wheels.

Rear-mounted mowers are integral mowers, mounted on the rear of the tractor. Mowers of this type do not have a frame in the same sense as a drawn or semi-mounted mower. Wheels are not used to support the mower. Rear-mounted mowers are lifted by the hydraulic control system. Mowers that are rear-mounted are generally designed to be used with a specific tractor.

Center-mounted mowers are also integral mowers designed for use with a specific model of tractor. They have the advantage of having the cutting parts located ahead of the operator where he can easily watch the work. Center-mounted mowers are usually more difficult to install on the tractor than the other types.

The *cutterbar* and its associated parts, including the pitman shaft, make up the most vital unit of a mower. These parts do the work of cutting. Draft, repair costs, and length of life of the mower depend upon the care given these parts. An understanding of how the cutterbar works is of prime importance.

The cutterbar of a mower, in principle, is a multiple set of shears. The reciprocating motion of the pitman moves the knife back and forth between the guards on the cutterbar. The knife sections, moving across the ledger plates, shear off the crop being mowed.

Some means must be provided to operate the knife. One end of the pitman is fastened to an off-center pin on the flywheel and the other end to the knife. Through the pitman, the rotary motion of the flywheel is transformed into reciprocating motion at the cutterbar. Some mowers use a pitmanless operation.

In a power-driven mower, the flywheel is usually driven through a chain or V-belt arrangement by a power shaft connected to the tractor power take-off.

Presentation by the Teacher

A basic knowledge of mowers and the principles underlying their design is essential in mower care and maintenance. The students must know the fundamentals of mower operation to understand the reasons for the different adjustments.

Have a mower of each type available in the school farm shop. Supplement these machines with appropriate visual aids. Identify the different parts of the mowers and explain their function. Stress particularly the function and operating principles of the cutterbar and associated parts, including the pitman shaft.

Explain how the cutterbar operates by tracing the mower power train to the tractor power take-off. The steps of teaching for "application" and "testing" would be similar to that presented in Chapter II.

Discussion Topics

1. What are the advantages and disadvantages of mowers as to the different kinds of mountings?
2. What are the component parts of each assembly on the mower?
3. What conditions may affect the mower knife speed?
4. Why is it necessary to know the parts of a mower?

Repairing the Mower

Preparation for the Teacher

Replacing Guards.—To replace guards, first remove the knife and then remove the guards that are defective. If the guard being replaced is equipped with a wear plate, adjust the plate so the knife is held properly in the guard. Replace the wear plate if badly worn and then aline the guards. Check guard bolts periodically to make sure they are tight.

Before replacing a guard, examine the ledger plate. Many times the guards were replaced when only new ledger plates were needed.

Replacing Ledger Plates.—Replace ledger plates when worn or dull using a mower guard and knife repair block.

Set the removed guard on the repair block. The only tools needed are a drift punch, a pin punch, a hammer, and a cold chisel. Drive the rivet through the ledger plate, using a drift punch. Then use the pin punch to drive the rivet out of the guard. Put on a new ledger plate. Put rivet in position, set riveting post under head of rivet, and swell with hammer. Chisel off rivet head flush with ledger plate if surface is not smooth for knife.

Knife-Head Guides.—The knife-head guide should be replaced if badly worn. Replace promptly a worn wear plate and ledger plate on inner shoe to avoid knife-head breakage.

Replacing Knife Section.—Hold the knife loosely in a vise or use a guard and knife repair block to support the knife-bar. Strike the back of the section above each rivet with sharp blows. This will shear the rivets and the knife-bar will not be bent if it is held securely against the support. Rivets should not be punched out prior to shearing as this enlarges the rivet holes and weakens the knife-bar.

When putting on a new section, be sure to get the rivets tight. First swell the rivets with hammer blows and then form the heads with a rivet set. Use knife sections designed for the machine being serviced and the job to be performed.

Straightening Knife.—If the knife becomes bent, straighten it in a vise and then try the knife in the cutterbar. With the knife holders properly set, the knife should work freely. If the knife is bent edgeways the knife-head may bind in the guides. This condition can be corrected by using a vise to bring the knife back to the original shape.

Sharpening Knife.—When sharpening knife sections, retain the same shear angle and bevel as that found on new sections. The angle must be correct so that the section will hold the grass against the ledger plate for a shear cut. The bevel of the section is highly important. An abrupt edge will tear the grass. A section with too wide a bevel will nick easily. The tendency is to grind away too much of the point and too little of the heel of the section. This changes the angle of shear to cause poor mowing.

Sections that have been sharpened too many times, or sharpened improperly, are likely to have the tempered edge ground away, exposing the core which resists shock, but does not retain a cutting edge. Also, a section that has been ground too short will not cut all the grass in the forward travel of the mower. Use a knife grinder with a grinding wheel that will restore the sections to the original angle and bevel.

Replacing Pitman.—The pitman is removed from the knife-head ball by use of a punch or a special tool. Adjustable pitmans are removed from the knife-head by removing a bolt or end cap. The pitman on most mowers is unfastened from the flywheel by removing a nut from the flywheel wrist pin.

When installing a new pitman, select one of the correct length and adjust it to fit securely. Also check cutterbar register and lead.

Presentation by the Teacher

Present each step to the students through well-planned demonstrations as explained previously. The steps of teaching for "Application" and "Testing" would be similar to those presented in Chapter II.

Discussion Topics

1. What determines the need for replacing guards? How is it done?
2. What is the purpose of wear plates? How can they be replaced and adjusted?
3. What is the purpose of ledger plates? How can they be removed and replaced?

4. What are the steps in replacing a pitman? What precautions should be taken?
5. Why is it essential to adjust a mower after making repairs?

Making Mower Adjustments

Preparation for the Teacher

Cutterbar.—To do an acceptable job of mowing, the knife sections and ledger plates must be sharp and have a shear contact. Cutting edges of the ledger plates must be in the same plane the full length of the cutterbar so as to have a shear cut. Knife holders must be set to hold sections against ledger plates and wear plates but must permit knife to run without binding. Wear plates under knife holders should be replaced when worn enough to cause sections to rise from contact with ledger plates at the points. The usual causes for cutting troubles in the cutterbar are: guards out of alinement, worn or maladjusted wear plates, bent knife-back, dull knife and ledger plates, and worn knife holders that are improperly set.

Alining Guards.—Alining the guards is an important and exacting operation. A new knife, or a used straight one that is in good condition, should be used in testing and setting the guards. Insert knife and set each guard up or down, as necessary, to obtain a shear cut between knife section and ledger plate. Raise knife holders so knife will have clearance and will not bind or be bent when alining the guards. Keep the guard bolts tightened. A loose guard may get out of line, catch the knife, and cause breakage. Bend down the high guards first and then bring up the low ones. Strike guards only at the thick part just in front of ledger plate. Be sure to tighten nut on guard bolt every time the hammer is used on the guard. Remove knife several times as you work in order to look across the ledger plates and be sure you are adjusting them in line. Guard wings should also be alined.

Keep points of guards sharp. Do not bend down lips of guard—choking will result. The lip of the guard is the portion that covers the ledger plate. Also see "Replacing Guards" under "Repairing the Mower."

Adjusting Wear Plates.—Wear plates under knife holders should be set ahead or replaced to take up wear on knife-back, and reduce play of knife-bar in neck of guards. When setting wear plates ahead, there should be enough clearance at front of sections to prevent sections from striking guards. Turned-down edges of wear plates must line up with one another to give knife bar a straight bearing along its entire length. Be especially careful to aline new plates.

Spacers or shims must be inserted between wear plates and knife holders when knives equipped with extra heavy sections are used.

Setting Knife Holders.—Remove knife before bending down the knife holder. Start at the outer end of cutterbar by pulling knife from under each holder and tapping holder down. Keep trying the knife until holder is set so knife works freely and at the same time the holder is down on knife. Set each holder in the same manner. If the holder is too tight on knife, strike holder between the bolts while knife is under holder. A knife working tight on bar will cause heavy draft. Aline guards before adjusting knife holders. Be sure all guard bolts are tight. After setting knife holders, try knife. Put oil on knife holders and wear plates and be sure knife is working freely.

Adjusting Cutterbar Tilt.—Run cutterbar level with the ground whenever possible. Should it be necessary to change tilt of cutterbar for short cutting or when cutting in hay that is lodged, cutterbar can be tilted by means of an adjustment.

Adjusting Height of Cut.—The soles under inner and outer shoes can be adjusted to regulate the height of cut for different field conditions. Be sure to have cutterbar the same height at both ends to assure an even cut. On rough or stony land, the cutting parts should be protected by adjusting the soles to raise the cutterbar.

Adjusting Pitman.—Some pitmans are adjusted by tightening the lower jaws attached to the knife-head to take up lost motion. Adjust the jaws snugly but not so tight that they bind and prevent free action of the knife. Other mowers use shims to take up any play. Many mowers have pitmans that are adjusted automatically. On these pitmans, the operator does not have to make adjustment to maintain proper tension. Some mowers do not use a pitman but use a cam type of operation. A pitmanless knife operated through a pendulum action uses a flexible strap in place of the knife-head. This strap is free to move up and down on each stroke for a fraction of an inch and knife-head guides or shims are not required.

Registering Knives.—To insure smooth cutting and light draft, the knife sections must center in the guards at the extreme inner and outer ends of pitman stroke. A knife out of register will not cut clean. Be sure pitman is properly connected, lifting spring has proper tension, and cutterbar is lowered to cutting position. On rear mounted tractor mowers the hinge bar should be 10 to 12 inches above the ground. Rotate pitman by hand, and at the end of the outer and inner strokes, note the position of knife sections in relation to the guards—if sections do not center in guards, the knife is out of register. If out of register, note whether the point of section is to right or left of guards, as the entire cutterbar assembly must be moved to place guards in correct position. Some mowers have a pitman stroke longer than the spacing of the guards, and the points of the knife sections will go past the guards. In this case, the point of the knife section should travel past a guard by the same amount at each end of the stroke to be in register. Several makes of mowers have movable washers or shims at the yoke to move the cutterbar in or out. By transferring one or more of these washers or shims and by lengthening or shortening the pull bar, proper knife register can be restored. Another method used to obtain proper register is to rotate the shoe hinge or yoke to move the cutterbar. With steel pitmans, adjust the length of the pitman to obtain proper register. Adjust the pull bar on all mowers to compensate for the movement of the knife. Other methods may also be used to adjust register of knife.

Adjusting Lead.—It is best to have mower on level ground or floor. Be sure cutterbar is not tilted and is parallel with ground. Pull outer end of bar back, taking up slack due to wear. One method of alinement is to run a cord down center of pitman, over center of knife-head ball, and out over and beyond outer shoe, keeping the string parallel with the pitman. If pitman and knife are in line, the back edge of knife should be parallel with cord.

If pitman and knife are not in line, turn eccentric bearing around hinge pin as far as necessary to bring the outer end of bar ahead until pitman and knife are in a straight line when working under ordinary cutting conditions. This adjustment usually restores original lead as well as alinement. Operator's manuals also list other methods of determining lead and alinement.

The mower, when it leaves the factory, has a certain amount of lead in the cutterbar—that is the outer end is set ahead of the inner end in relation to a parallel line extending across the face of the flywheel or in some other convenient manner at right angles to the direction of travel. Check and adjust lead according to the instructions in the operator's manual. This setting compensates for the backward strain on the bar when cutting, and enables the pitman and knife to run in a straight line when cutting under ordinary conditions. Wear may occur on shoe hinge pins and in pin bearings in yoke, allowing the outer end of the bar to lag or go back until knife is running at a backward angle. The outer end of the cutterbar should have a lead over the inner end of about 1/4 inch per foot length of cutterbar.

Adjusting Grass Board and Stick.—A heavy coil spring permits a certain amount of flexibility of the grass board.

The grass stick is adjustable for short or tall crops. The grass board and stick must be set properly to make a path for the inner shoe on the next round.

Lifting Spring.—Have enough tension on lifting spring so bar will rise easily and float rather than drag, yet move steadily over the ground. If there is not enough tension, the bar will ride on the ground and increase draft. Too much tension will not allow the bar to follow the uneven ground, and the spring may hold it up after it has risen over a mound or other obstruction. When properly adjusted, the lifting spring carries the bulk of the weight of the cutterbar and reduces the friction of bar on the ground. Refer to the operator's manual for other lifting methods employed.

The lifting linkage must be adjusted so the cutterbar will leave the ground when raised. The outer end of the bar should leave the ground just before or at the same time as the inner end. If outer end rises too slowly, tighten adjusting bolt. On some mowers, a chain swivel adjustment can also be shortened to take up wear and to make outer end of bar rise faster, or lengthened to make outer end of bar rise slower.

Adjusting Slip Clutch.—Mowers have a slip clutch to protect the working parts from damage if the cutterbar becomes clogged.

Before the mower leaves the factory, the slip clutch is adjusted to meet ordinary conditions. If adjustment is necessary, set the slip clutch just tight enough to do ordinary work without slipping, but loose enough to slip if there is clogging.

The procedure for adjusting the slip clutch is similar on all mowers—an adjusting nut is tightened against a coil spring that holds the clutch jaws together.

Adjusting Drive Belts.—Keep the belts just tight enough so they will not slip. On most mowers, the belt is adjusted by moving one of the sheaves.

The following list of suggestions will help to keep the drive belt in good condition and make it last longer:

1. Do not pry belt over sheaves.
2. Take up the initial stretch that naturally occurs in new belts. On a new belt check tension frequently during first few days.
3. Keep belt tight enough to prevent slippage.
4. If cutterbar clogs, shut off power and clear the cutterbar before continuing operations.
5. Promptly wipe off any grease or oil that falls onto belt, using a cloth moistened with cleaning solvent.
6. Protect belt against moisture and lubricants.

Adjusting Drive Chain.—Most drive chains are enclosed and are adjusted by an idler or by means of an adjusting plate held in place by a set screw. See the operator's manual for the mower being serviced for detailed instructions.

Adjusting Cutterbar Safety Release.—Mowers usually have a cutterbar safety release which allows the cutterbar to break back when striking an obstruction. This helps to prevent damage to the cutting parts.

If the safety release permits the cutterbar to swing back too easily, adjust the spring tension on the lock. Be careful not to get the lock too tight or the cutterbar will be damaged if it strikes an obstruction.

See the operator's manual for the proper method of relatching the breakaway device.

Some center-mounted mowers have different means of protecting the cutting parts. Several types use an ignition cut-out device that stops the tractor engine when the cutterbar strikes an obstruction. At least one center-mounted mower has a means of disengaging the tractor clutch to stop the tractor and the motion of the cutting parts.

Presentation by the Teacher

To make mower adjustments have on hand the different types of mowers for demonstrational purposes. Each step as outlined under preparation for the teacher is to be presented through well-planned demonstrations for the students as previously explained. Students will then actively perform on a machine the jobs demonstrated by the teacher. The steps of teaching for "Applications" and "Testing" would be similar to those presented in Chapter II.

Discussion Topics

1. What determines the need for replacing guards? How is it done?
2. What is the purpose of wear plates? How can they be replaced and adjusted?

3. What is the purpose of ledger plates? How can they be removed and replaced?
4. What are the steps in replacing a pitman? What precautions should be taken?
5. What may result if cutterbar is out of alinement? Out of lead? How correct such problems?
6. Why do mowers have a tilt adjustment on the cutterbar?
7. How do you test for slip clutch release? Breakaway release?

Lubricating the Mower

Preparation for the Teacher

The life of a mower depends largely on the lubrication it receives. Regular and proper lubrication increases efficiency; lessens draft; and reduces wear, breakdown, and the need for repair parts. Follow the manufacturer's recommendations for the type of lubricant and lubrication intervals for the mower being studied.

Some accepted rules for good lubrication service include:

1. Wiping the dirt from grease fittings before lubricating.
2. Replacing all missing grease fittings.
3. Using a grease gun to lubricate bearings.
4. Oiling the mower cutting friction parts, except when working in dry, dusty, or sandy conditions. In these conditions, run the cutting parts dry to prevent an accumulation of grit that would increase wear and make cutting difficult.
5. Draining enclosed gear cases, flushing with a safe solvent, and refilling once each season. Use the weight of lubricant recommended by the manufacturer.

Presentation by the Teacher

Demonstrate the proper lubrication of a mower, following the manufacturer's recommendations. The students must then perform each step of this activity, following which the teacher should conduct a testing procedure.

Discussion Topics

1. What are the differences between oil and grease as lubricants?
2. What practices do you use to keep lubricants clean?
3. What may be the results if a contaminated lubricant is used?

4. How often should the several parts of a mower be lubricated when in use?
5. Under what conditions is it not desirable to lubricate certain parts of the mower?

Operating the Mower

Preparation for the Teacher

Before opening the field check the mower carefully for correct adjustment. Run mower slowly for a short time and observe knife, pitman, and other moving parts to see that they are operating freely and normally.

Daily Maintenance.—Lubricate the mower as specified in the operator's manual. Check the mower for loose or missing nuts and cotter pins; tighten or replace as necessary. Watch the cutting parts for signs of wear or misalinement. If the mower is not doing a good cutting job, find and correct the cause. Be alert at all times to detect frayed or worn drive belts and weak or badly worn parts. Make replacements promptly before serious breakage or damage occurs.

Hydraulic Control.—Hydraulic devices are used to raise and lower the cutterbar. A hydraulic lift raises or lowers the cutterbar quickly and easily. Obstructions are more easily cleared, with less possibility of breakage or injury. Some hydraulic systems permit selective positioning of the cutterbar while others raise or lower the cutterbar to the full limit of travel without any intermediate stops.

A hydraulic remote cylinder is used with semi-mounted mowers. The cutterbar of mounted mowers is raised and lowered by means of a linkage connected to a raising arm that is operated hydraulically on the tractor.

Cutting the Hay.—When entering a field, many prefer to first cut the back swath. Then reverse the direction of travel and continue around the field, making right-hand turns.

This is the proper method of mowing when a left-hand side-delivery rake is to be used to windrow the hay. When the rake is driven in the same direction the mower has traveled, the hay will be raked into windrows with the leaves inside, protected by the stems. In this way, the hay will cure properly. If crushing or crimping the hay at the time of cutting, the curing is altered and may later affect the method of handling.

Cutting Speed.—Under most conditions, a tractor mower can travel at 3 to 4 miles per hour without causing undue wear.

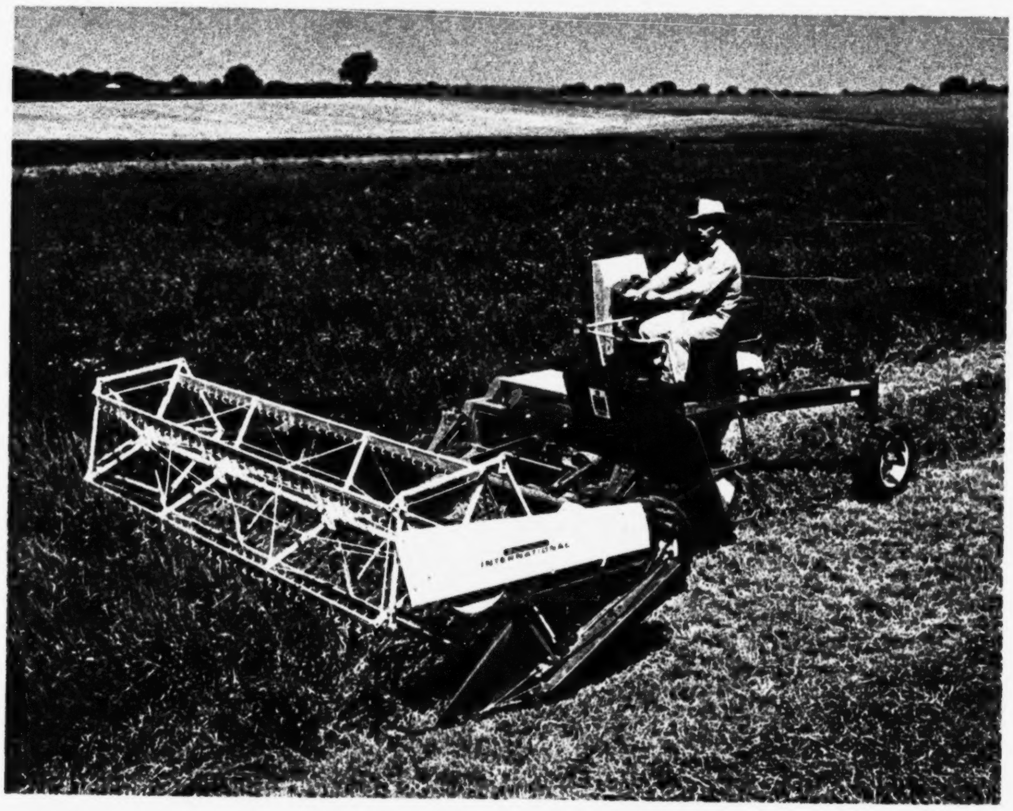


Figure 37.—Self-propelled mower, crusher, and windrower.

Avoid excessive speeds. Various mowing conditions require different mowing speeds. Best results will be obtained by running the tractor at the travel speed that will meet field and crop conditions, or the speed where the smoothest mowing action is obtained.

Always keep tractor engine running at a normal speed. With a mower driven by the tractor power take-off, running the tractor engine slowly reduces the knife speed and may cause the knife to clog where cutting is heavy. The power take-off speed is governed. Where difficult conditions make it necessary to slow down travel speed of tractor, the operator should shift to a lower gear in the transmission rather than throttle the engine to slow speed. By shifting to a lower gear, the engine can be kept at its rated speed which will keep the knife running at the proper speed for best results.

Transporting Mower.—When moving the mower from one field to another or any considerable distance, place the cutterbar in transport position. See instructions in the operator's manual. Practice safety when transporting a mower by disengaging tractor power take-off. When raising or lowering cutterbar by hand, keep fingers away from cutting parts.

Trouble Detection.—The following list includes common mower troubles and their causes. This check list will aid in determining the cause of faulty mower performance.

Heavy Draft, Side Draft, and Uneven Stubble

1. Improper assembly
2. Lack of lubrication
3. Lagging cutterbar and uneven adjustment of shoe soles
4. Worn knife-head, guides, knife holders, or wear plates
5. Knife out of register
6. Guards loose or out of line
7. Dull, broken, nicked, or loose knife sections or ledger plates
8. Knife holders binding
9. Not enough tension on lifting spring
10. Too much tilt of cutterbar
11. Lips of guards bent down too far

Knife and Knife-Head Breakage

1. Worn knife-head, guides, knife holders, and wear plates
2. Warped or twisted pitman
3. Guards loose or out of line
4. Dull knife sections or ledger plates
5. Broken or nicked knife sections
6. Bent knife
7. Knife out of register
8. Lagging of cutterbar
9. Too much tilt of cutterbar

Choking Down

1. Lagging of cutterbar
2. Knife out of register
3. Guards loose or out of line
4. Too much tilt of cutterbar
5. Worn cutterbar parts
6. Lifting parts of cutterbar out of adjustment
7. Lifting spring not properly adjusted
8. Knife-head guide bolts loose
9. Fender rod or grass stick not properly set
10. Knife holders not properly set
11. Lips of guards bent down too far
12. Dull cutting parts

Safety.—The primary responsibility for safety with farm machinery rests with the operator. A slight error in judgment or momentary lack of attention can cause a serious accident involving loss of time, injury to the operator, and damage to property. Among the prerequisites for farm safety are the knowledge of how the machine works, how to operate it, and an awareness of the possible danger points on the machine.

Safety measures that should be observed in connection with the mower operation are given in the following list:

1. Check the mower before using to make certain it is properly adjusted and in good working condition
2. Have the safety shields properly installed before starting the mower
3. Attach the mower properly to the tractor
4. Disengage the tractor clutch and power take-off before clearing a clogged cutterbar
5. Permit only the operator to ride the tractor
6. Tighten the slip clutch only enough to keep working parts in operation
7. Have the breakaway device adjusted properly
8. Operate at a speed suitable for the crop being cut
9. Cross rough areas and depressions carefully
10. Work behind cutterbar when lubricating or making adjustments near knife
11. Transport mower only when cutterbar is locked securely in raised position and tractor power take-off is disengaged
12. Make certain that all is in the clear before starting the mower

Presentation by the Teacher

Satisfactory mower performance depends upon a knowledge of mower capabilities and limitations. Operate the mower at the speed for which it is designed, observing safe mower operation. Observe the student's participation in all phases of mower operation, and provide a suitable test.

Discussion Topics

1. What is the best procedure to use in opening a new field?
2. What is a normal speed for mowing?
3. What are several precautions to follow when transporting a mower?
4. What care needs to be given to the hydraulic control system?
5. What are several causes of heavy draft? How can excessive draft be prevented?

Storing the Mower and Removal From Storage

Preparation for the Teacher

Servicing the Mower

Clean the mower thoroughly, including the cutting parts prior to storage.

Inspect the mower for worn and broken parts. Make a list of needed parts and order immediately. Install the new parts before the next work season starts.

Lubricate the mower completely. If the mower has an enclosed gear case, drain the case, flush with a safe solvent, and refill with the weight of lubricant recommended by the manufacturer.

Examine the cutting parts carefully. Sharpen the knife if needed.

Paint the mower as needed to protect it from rust.

Coat exposed working parts with heavy grease or rust preventive.

Protection of Machine.—If at all possible, store the mower in a machine shed where it will be out of the weather and safe from damage.

Protect rubber tires by storing the mower in a cool, dark place. Block up the mower to take the weight off the tire or tires. If the mower must be stored outside, remove the wheels and put them where the tires will be protected from the weather.

Put a wood shield over the guard points to protect the points and also to protect persons and animals from injury. In a like manner, cover knives that are removed from the machine. Remove the knife and store separately.

Removal from Storage.—Clean the mower thoroughly and replace any parts that were removed for storage.

Completely lubricate the mower.

Inspect the mower and check all adjustments, especially register, lead, and cutterbar tilt.

Check pressure of tires and inflate as recommended in the operator's manual.

Presentation by the Teacher

Demonstrate how to protect a mower from the elements, birds, and livestock when in storage.

Phases of storage, such as lubrication, which have previously been demonstrated need not be redemonstrated. Have each student or group of students prepare a mower for storage and removal from storage. Test the ability of students to perform these jobs.

Discussion Topics

1. What precautions should one observe when cleaning a mower?
2. Why store a mower under protective cover?
3. What precautions are necessary to keep a mower from rusting when in storage?
4. Why relubricate a mower when removed from storage?
5. In storage of a mower what are the advantages and disadvantages of open sheds, closed sheds, polyethylene covering, rust preventive sprays, and painting?

Chapter V. Soil and Water Management

Kinds of Activities in Soil and Water Management

AN AMPLE AMOUNT of fertile soil is of utmost importance in the production of food, fiber, and oils for the use of mankind. Man must maintain, and even increase, the productiveness of the land while it is entrusted to his use. For the wellbeing of posterity we have a moral responsibility to pass on the land in a high state of fertility and without erosion loss from either

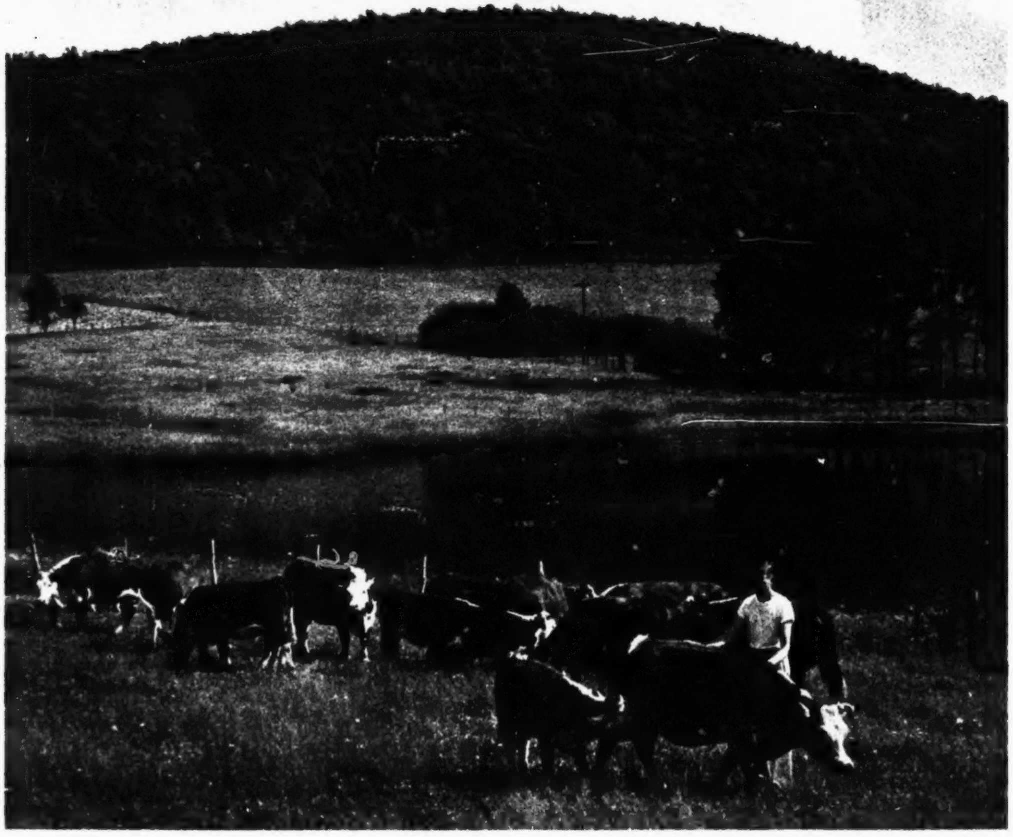


Figure 38.—A farm pond provides water for livestock, facilities for recreation, and aid in fire protection.

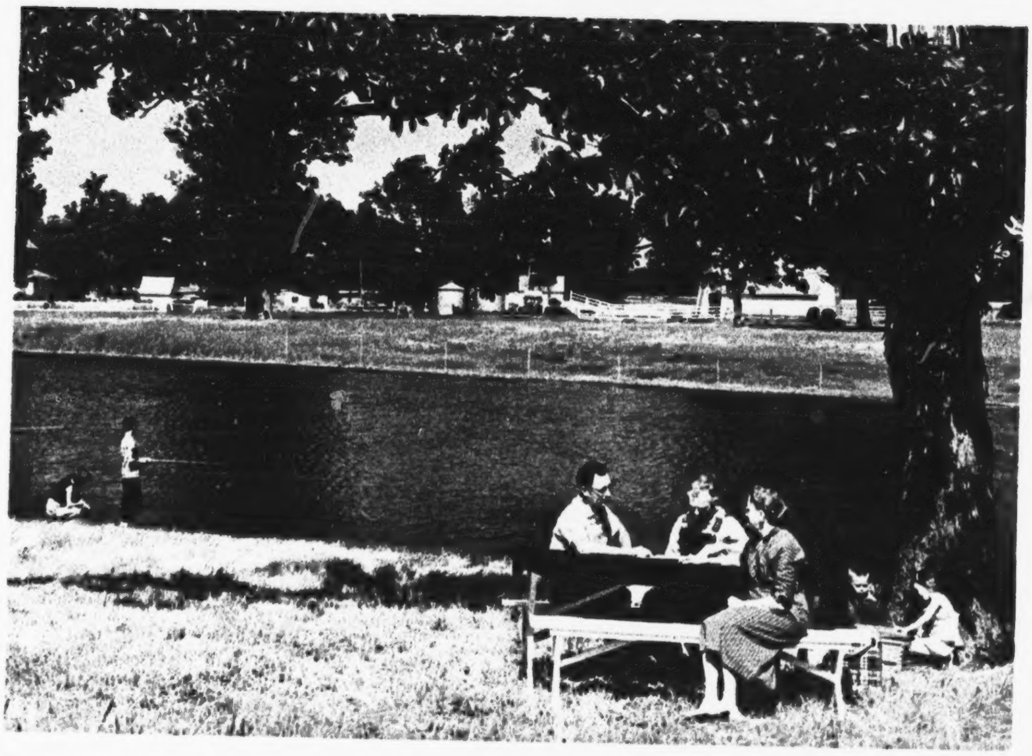


Figure 39.—A farm water storage system which provides wholesome recreational facilities.

wind or water. Therefore, soil and water conservation and erosion control is imperative for the welfare of our society.

Water conservation is of increasing importance for farm and pasture lands and in woodlands. We must plan ahead for watershed protection to meet the increasing uses and demands for water.

Conservation practices that control soil erosion also help to prevent wasteful run-off, lessen flood damage, reduce silting of streams and reservoirs, provide facilities for recreation, and help to assure ample water for rural and urban needs. Thus, a sound base is established for treatment and use of each kind of land by man. A sound water conservation program also prevents the hazards that may occur when it is not controlled. Likewise, controlled drainage increases crop yields, conserves water, reduces siltation, and often removes health hazards.

The purpose of each comprehensive farm and ranch conservation program is to develop a plan that makes maximum productive use of every acre. It makes farming and ranching possible at top capacity with a minimum loss of soil and water.

The Soil Conservation Service, which provides technical assistance to farmers and ranchers in soil conservation districts

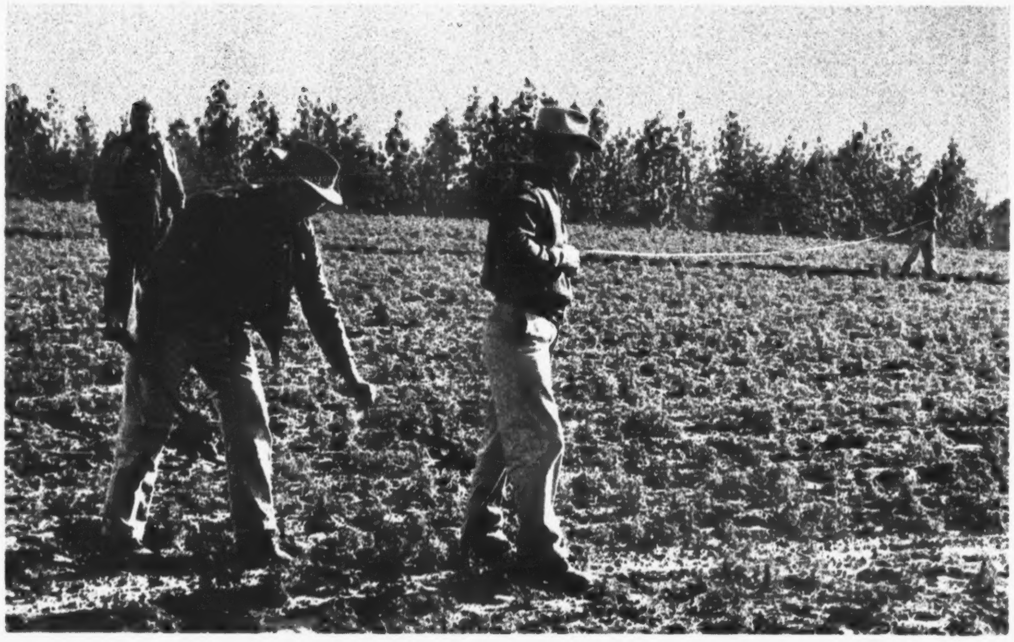


Figure 40.—Laying off a parallel terrace system.

can also provide aerial photographs and soil survey map as a first step in setting up a sound long-range land-use program. This map, as a result of land surveys, shows the kind of soil, slope, degree of erosion, and general physical condition of land for all areas on each farm or ranch in a conservation district. It also classifies the land according to its capability, which can be used as a guide by the land owner in deciding what the land can do and how it should be operated. Refer to Chapter III for a listing of many objectives and suggested procedures under Soil and Water Management.

Making Land Surveys

This will include activities such as planning an irrigation system, laying out a farm field on the contour, establishing terraces, planning a drainage system, planning water storage reservoirs or ponds, determining acreages, locating property lines, and doing differential and profile leveling.

Preparation for the Teacher

In order to perform these activities correctly it is necessary to know how to set up and use a farm level and supporting

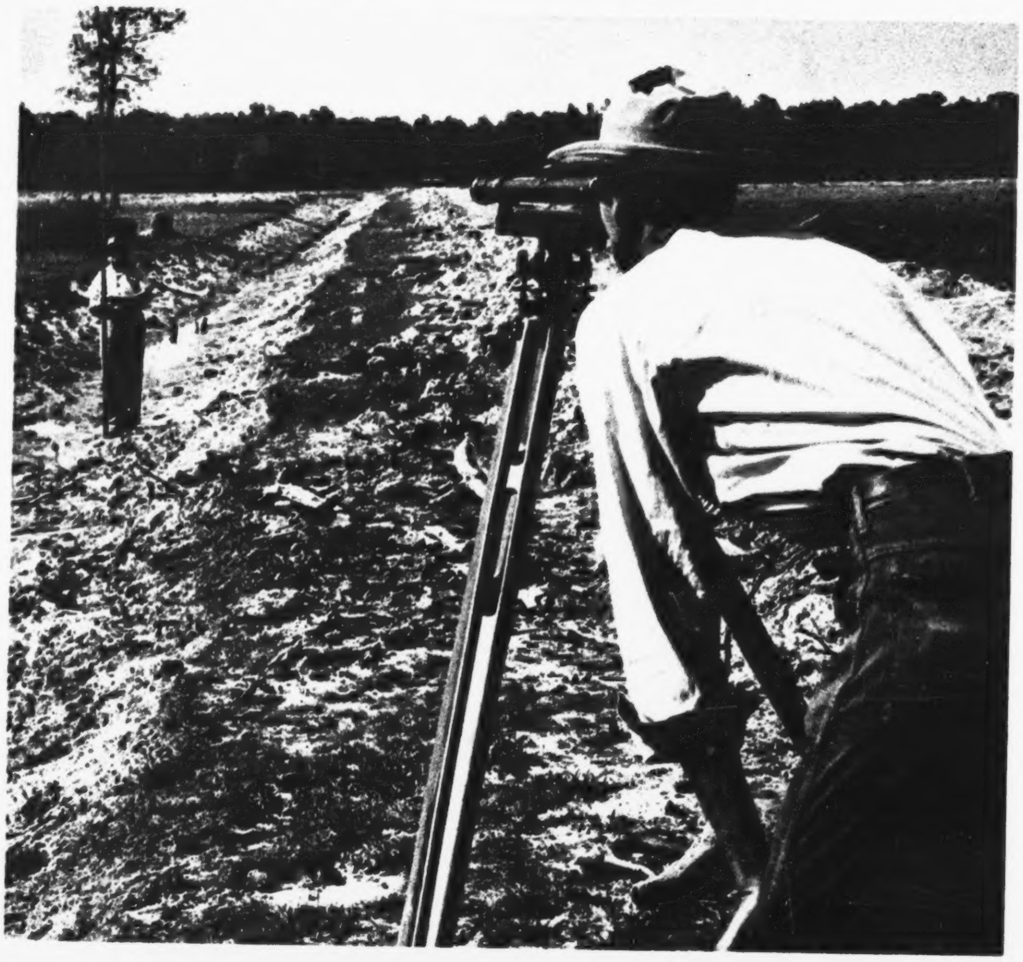


Figure 41.—Using a farm level to determine the slope for drainage ditch construction.

equipment. This job only will be presented in detail under Soil and Water Management. However, other jobs will be mentioned.

Using the Farm Level.—Many devices are used in establishing elevations, such as a carpenter's level securely mounted on a triangular frame with a wide base, a carpenter's level on which sights are mounted similar to those on a rifle, a garden hose filled with water and having a plastic tube at each end, hand level, a farm level with a reliable telescope, and an engineer's transit.

The farm level is generally recommended because it is inexpensive, simple to operate, sufficiently accurate for most land leveling and other farm surveying purposes. The level should have an adjustable head and a sturdy tripod.

Other useful items are two graduated rods with targets, a set of chaining pins, chain or tape, a hatchet, and a book in which to record field data will also be needed.

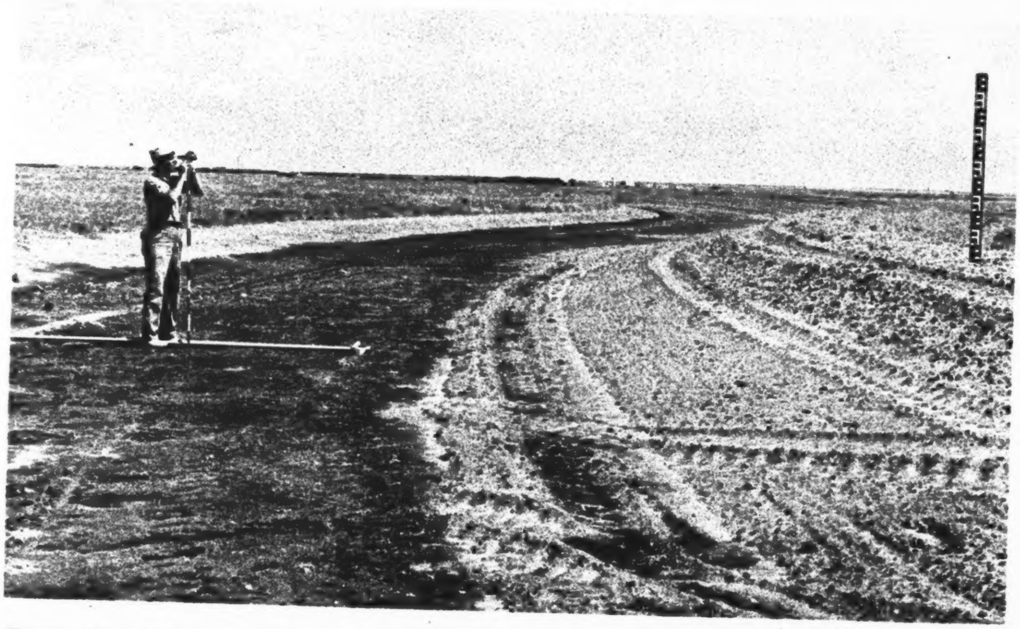


Figure 42.—Using a hand level when constructing a large diversion terrace for runoff water.

Setting up the Farm Level.—When preparing to use the instrument, remove it from the box and screw it onto the tripod head. Remove the lens cap and replace with sunshade if provided with the instrument. Set up and focus the instrument according to the following steps:

1. Loosen wing nuts on tripod.
2. Spread tripod legs about 3 feet apart. Adjust the location of one leg so as to make the tripod head approximately level. Set each leg firmly into the ground. On slopes place two legs downhill.
3. Tighten tripod wing nuts but do not use extreme force.
4. Place telescope over two opposite leveling screws.
5. Adjust these two leveling screws simultaneously and in opposite directions, keeping them snug against the foot plate. Do not force these screws. Bring the bubble to approximate center.
6. Rotate the telescope 90 degrees to a position over the other pair of leveling screws. Adjust these as in step 5 until the bubble is centered.
7. Repeat steps 4, 5, and 6 until the bubble remains centered at all positions. The leveled instrument will now give a level line of sight.
8. Sight the telescope and bring the cross hairs into sharp focus by adjusting the eyepiece slide.
9. Sight through the telescope and focus on the rod by turning the focusing screw until the numbers are sharp and clear. Read the rod after making certain that the bubble is still centered.

Reading the Rod.—Leveling rods are numbered from the bottom to the top so that the reading obtained with the instrument represents the distance from the point on which the rod is resting up to the line of sight. Rods supplied with farm levels are usually calibrated in feet and inches by 1/8 inches. Read the leveling rod as follows:

1. After focusing on the rod, make certain the bubble has not moved off center.
2. Sight through the telescope and note the reading on the rod as determined by the horizontal cross hair.
3. Each black mark, and each space between black marks is 1/8th of an inch wide on a farm leveling rod.
4. Follow a habit of looking at the bubble just before and after each reading to be certain it is centered.
5. Avoid leaning on the instrument while sighting as this may affect the position of the bubble.

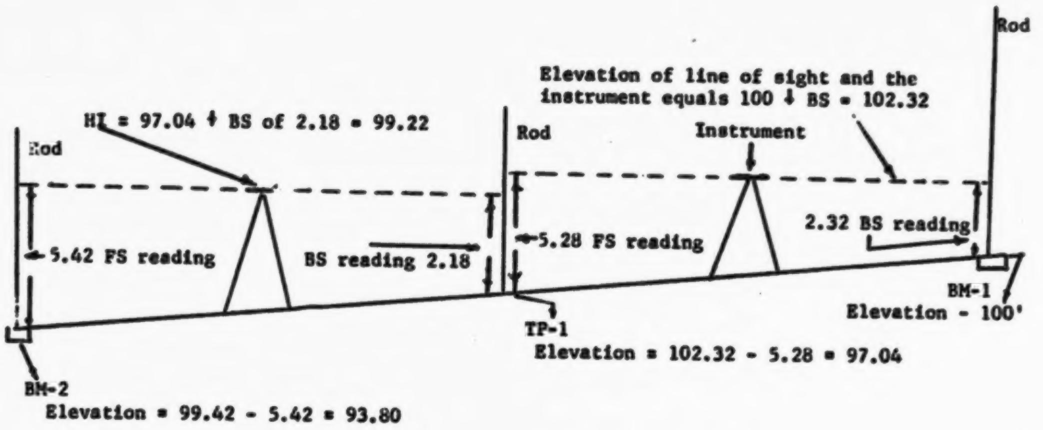
Some of the duties of a rodman are as follows:

1. Holding the rod plumb. Stand directly behind the rod and sight along its edge to get it into a vertical position.
2. Setting the target on the rod as directed by the instrument man.
3. Knowing and correctly interpreting all signals made by the instrument man.
4. Holding the rod in position until instrument man has recorded the reading in his field data book.

Determining Elevations.—The elevation of a point refers to its distance above an arbitrarily chosen level surface, called the datum plane. The standard datum plane used on large projects, such as railroad and highway construction, is sea level. For farm surveying, elevations are seldom referenced to sea level, but rather to a bench mark (BM) that has been given an arbitrary elevation. Always assign an elevation large enough so that no point on the survey will fall below zero elevation.

A bench mark is a permanent point of known or assumed elevation. Establish one or more bench marks for work of a permanent nature, such as for drainage, irrigation, and erosion control structures. For a bench mark, drive a long steel rod or pipe into a firm position, or use a spike driven into a permanent corner post or tree. Note the location of all bench marks in the field book. If several are established, assign an elevation to one, such as 100 feet, and determine the elevation of the others in relation to the first by use of the leveling instrument. This procedure is called differential leveling. Steps in *differential leveling* are as follows:

1. Set up and level the instrument as outlined previously. Locate the instrument 100 to 200 feet from bench mark one (BM-1), depending upon power of the telescope and land slope.
2. Prepare a page in the field data book for differential leveling notes using the following column headings from left to right: Station (Sta.), Back Sight (BS), Height of Instrument (HI), Fore Sight (FS), and Elevation


Rod
Elevation of line of sight and the instrument equals 100 + BS = 102.32
HI = 97.04 + BS of 2.18 = 99.22
Rod
Rod
Instrument
5.42 FS reading
BS reading 2.18
5.28 FS reading
2.32 BS reading
BM-1
Elevation - 100'
TP-1
Elevation = 102.32 - 5.28 = 97.04
BM-2
Elevation = 99.42 - 5.42 = 93.80

Sta	BS	HI	FS	Elev	Notes
BM-1	2.32			100.00	Jan. 10 - 1964
		102.32			Cloudy
TP-1	2.18		5.28	97.04	Temperature 26°
		99.22			
BM-2			5.42	93.80	

Figure 43.—Differential leveling with data sheet.

(Elev.). Explanatory notes or sketches needed to identify and locate the bench mark, as well as the date, are placed in a right hand column on each page.

3. Obtain a rod reading on BM-1. This reading is called a BS, as are all readings on points of known elevation. A backsight on a point of known elevation is always needed after the instrument has been set up at a new station. Record the BS reading in the field data book opposite the point on which it was taken.
4. Add the BS reading to the bench mark elevation to obtain the HI.
5. Enter the HI in the field data book.
6. Establishing a Turning Point (TP) in the general direction of BM-2. A TP is a temporary point, the elevation of which is determined so the instrument may be moved. Use a solid object for the TP which will not change in elevation while it is being used. The rodman often drives his hatchet solidly into the ground for use as a base at each TP.
7. Take FS reading on TP-1, making certain the bubble is centered. A FS is a rod reading taken on a point of unknown elevation. The elevation of the TP is obtained by subtracting the FS from the HI. To avoid misplacing BS and FS readings always compute elevations as the work progresses.
8. Record the FS reading and the TP elevation in their appropriate places.
9. Set up the level on the other side of TP-1. The instrument does not have to be set up in an absolutely straight line between FS and BS points.

10. Take a BS reading on TP-1, which is now a known elevation, to determine the new HI. Then take an FS rod reading on a new TP if needed, or on BM-2 if it is close enough. Determine the elevation of BM-2 by subtracting the FS reading from the last HI.
11. Continue to other bench marks and establish their elevations in reference to BM-1 in the same manner as above.
12. Check your arithmetic in the field data book by adding all the BS readings and all the FS readings. The difference between the totals of each is equal to the change in elevation between the first and last points. (See fig. 43.)

The 12 steps listed here include the procedure used in differential leveling for determining the relative elevations of two or more points. When all the points are located at known intervals along a line as for a terrace, the procedure is called profile leveling. Profile leveling differs from differential leveling only in that more than one foresight (FS) is usually taken on unknown points from each instrument setting.

Presentation by the Teacher

Demonstrate differential and profile leveling on a farm through use of a farm level and supporting equipment to show how these are used in performing activities listed under "Making Land Surveys." Have each student or group of students perform such leveling jobs on actual farm field situations. Provide essential tests to the students covering these field applications.

Discussion Topics

1. How is the farm level used to determine acreage in a field with uneven terrain?
2. What supporting equipment is used with a farm level in differential leveling? Profile leveling?
3. What do the following abbreviations designate—BM, BS, FS, TP, HI, Sta., and Elev.?
4. What steps are necessary to level the instrument for use?
5. What kinds of rods are used in surveying? How many needed?
6. How are land locations described in different parts of the United States?
7. What care should be given the farm level and supporting equipment when used? In storage?

PLANNING, CONSTRUCTING, AND MAINTAINING TERRACES AND DRAINAGE SYSTEMS

A terrace is usually an earthen embankment adjusted to soil type and slope of land. The main purposes of a terrace are to control run-off in areas of surplus water and to conserve

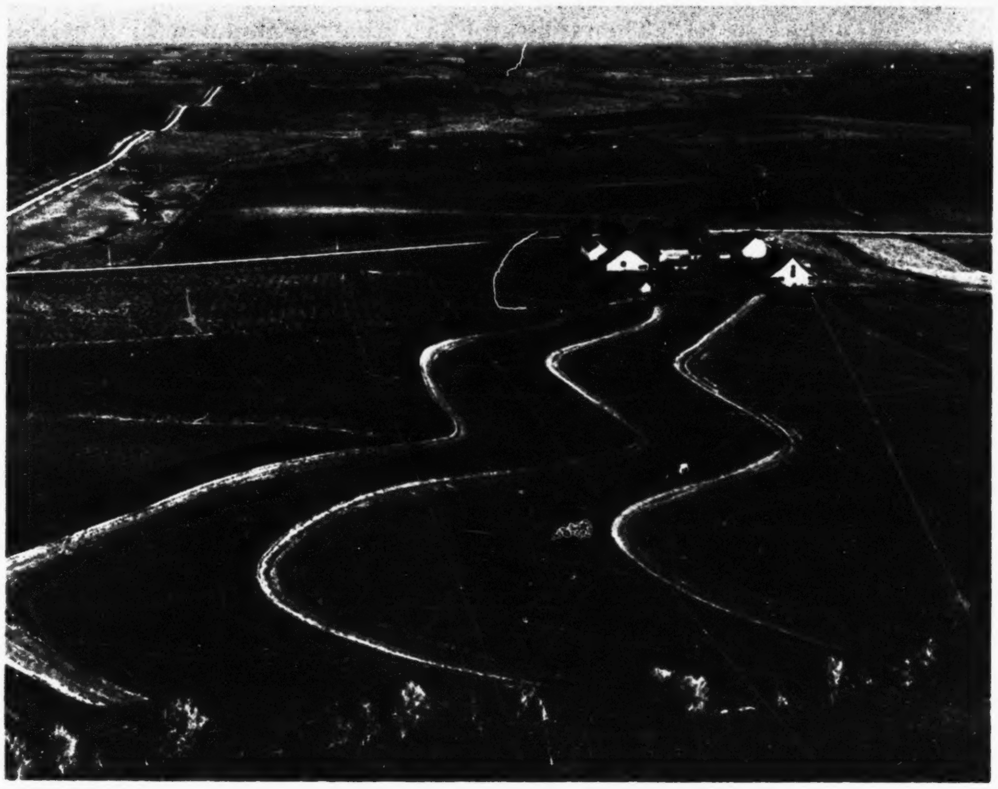


Figure 44.—Broad-based terraces in contoured fields.

moisture on the less humid or arid areas. Thus terraces assist in soil erosion control and conserving and disposing of water.

There are several types of terraces, but the two principal ones are graded terrace and level terrace. Each has several variations best suited to soil, moisture, climate, land slope, or cropping conditions.

There are several types of drainage systems, both open and closed, with each best suited to certain prevailing conditions. It is estimated that nearly one-fourth of our cultivated acreage has some form of constructed drainage, but much of it is inadequate and needs to be improved. A considerable portion of the land not drained at present would benefit from a well-planned drainage system.

Preparation for the Teacher

The Soil Conservation Service has a staff of technicians in soil conservation districts available to assist in staking out terrace lines and forming embankments, ditches, spillways, drainage systems, irrigation systems, water storage, and other essential soil erosion control and water conservation features.

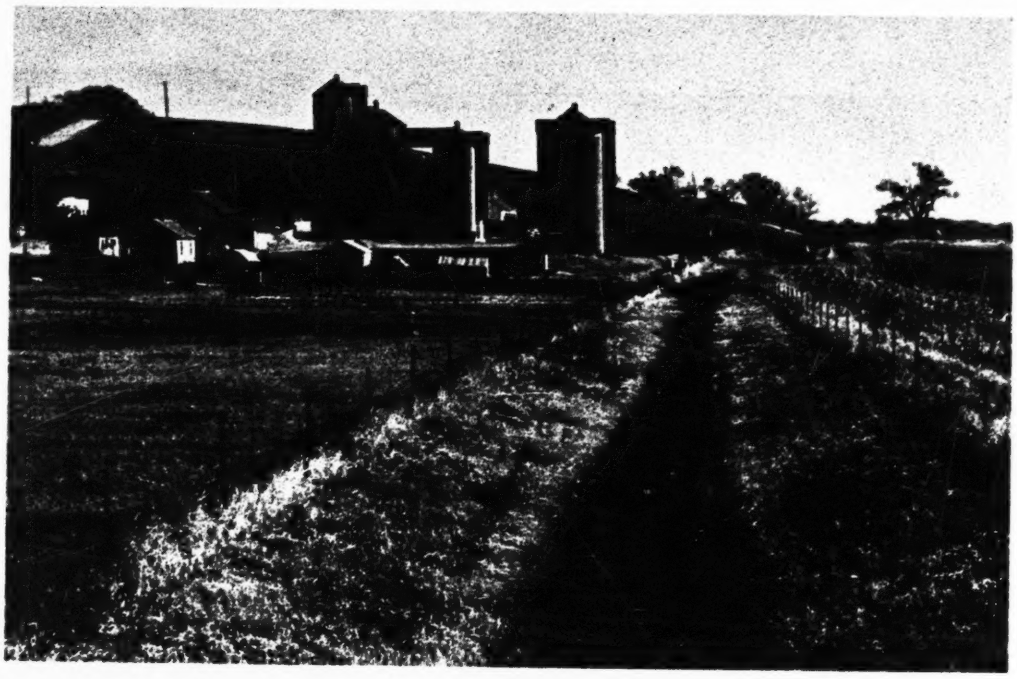


Figure 45.—A grassed diversion ditch into which a terrace empties.

As the teacher prepares for this job it would be well to study and plan in a detailed manner as shown for Preparation for the Teacher under "Making Land Surveys," which among other things includes the use of the farm level in differential and profile leveling. Much of this information is also applicable to this job.

Presentation by the Teacher

After study and planning, demonstrate in a field situation how to construct and maintain terraces and drainage systems. Have students perform such jobs as they relate to local farming conditions and then provide essential tests covering these activities.

Discussion Topics

1. What are several purposes of a field terrace? Types?
2. What factors need to be considered when selecting a type of terrace?
3. What steps would you follow in planning, constructing, and maintaining a field terrace?
4. What tools and equipment will you need to know how to operate in laying out, constructing, and maintaining a terrace? A drainage system?
5. How does a terrace fit into your cropping system?

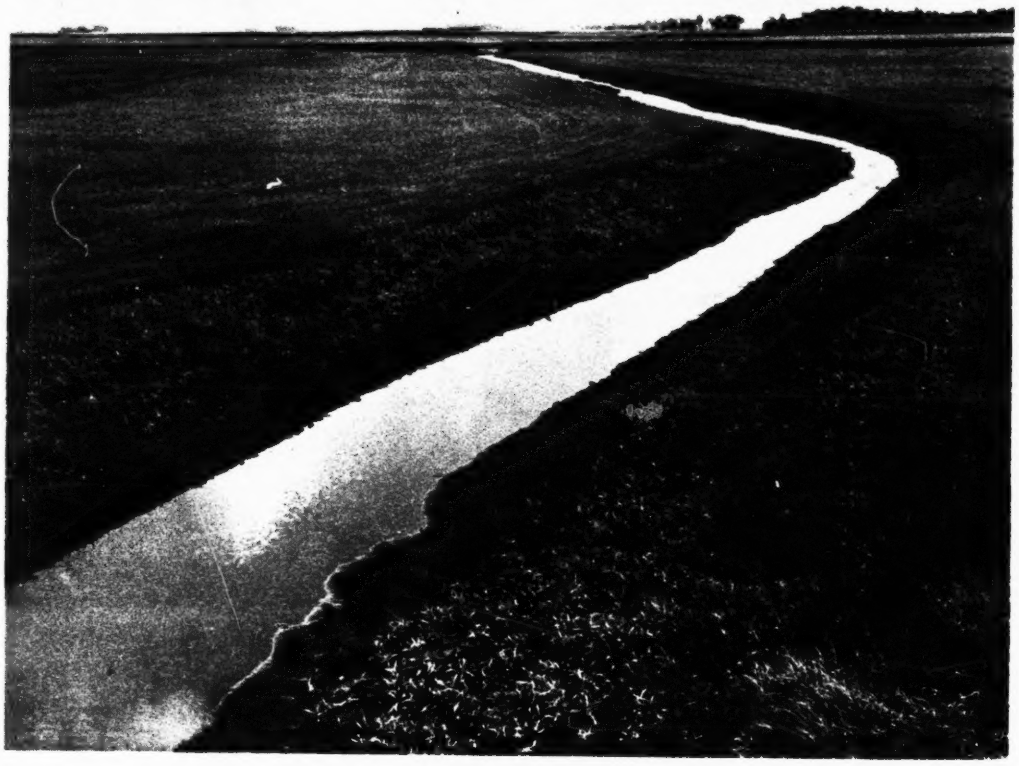


Figure 46.—An open-type drainage system that serves several farms.

6. What are the differences between open and closed drainage systems?
7. What determines the most suitable drainage system for your farm?
8. What is the cost of installing the different kinds of drainage systems? Terraces?
9. What are the main purposes of a drainage system?
10. What lands are not in need of drainage? Terracing?

Installing and Operating Irrigation Systems

Irrigation is the artificial application of water to supplement rainfall in crop production. Irrigation of farm lands has spread from the semi-arid areas to all of the States. Today many humid areas resort to supplemental irrigation to meet critical periods and seasonal needs of crops. The two main systems of bringing water to the land is by *pump* and *by gravity flow* from streams and storage reservoirs. There are many methods of applying water to the land with each best suited to certain soil, subsoil, crop, climate, season, terrain, and economic conditions. Some of the irrigation methods, each with variations, used in applying water are sprinkling, subirrigation, furrowing, and flooding.

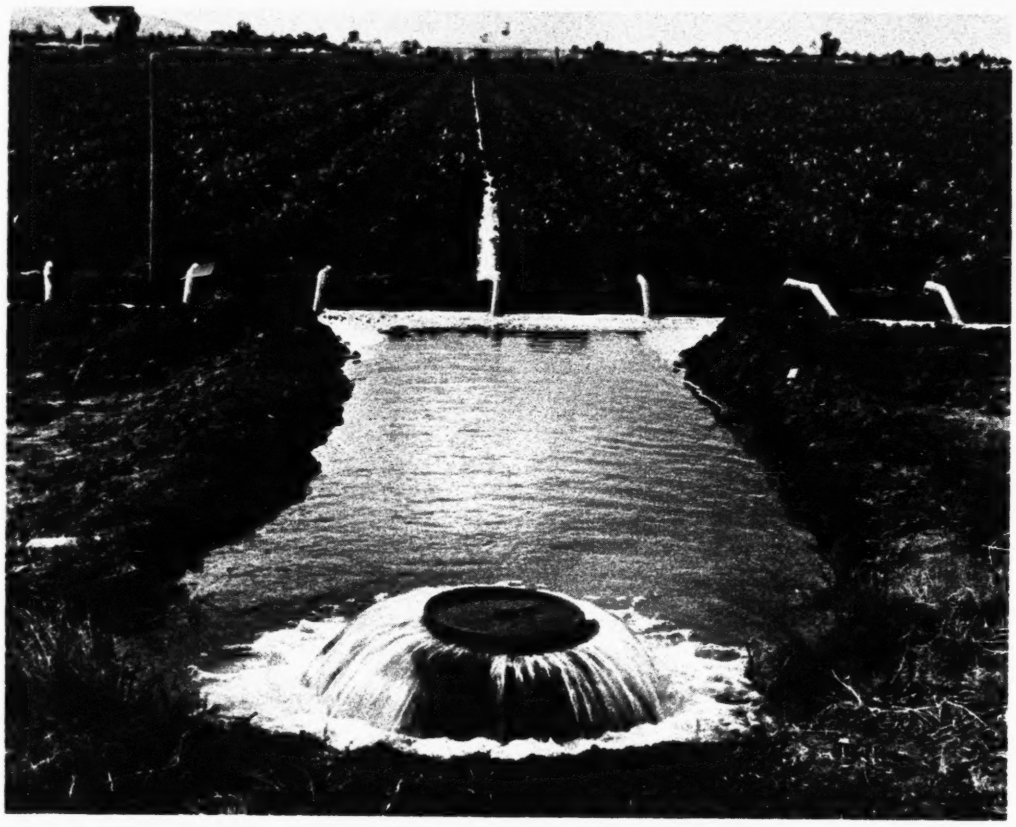


Figure 47.—An underground water system gate showing siphons for row-crop irrigation.

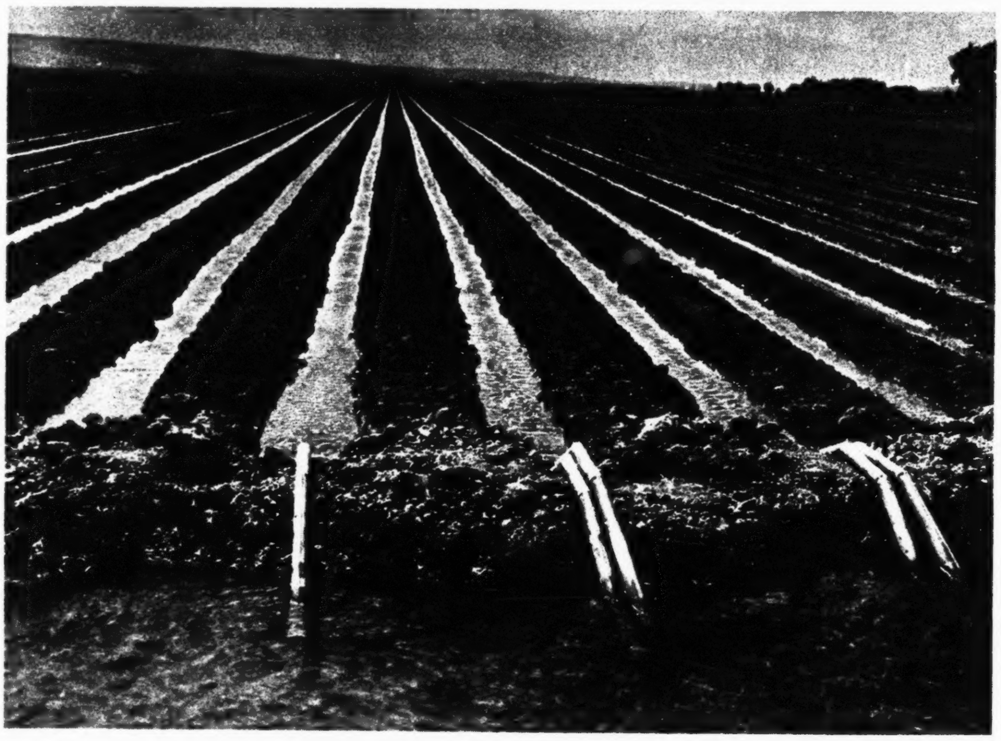


Figure 48.—Irrigating up a crop planted on properly levelled land.

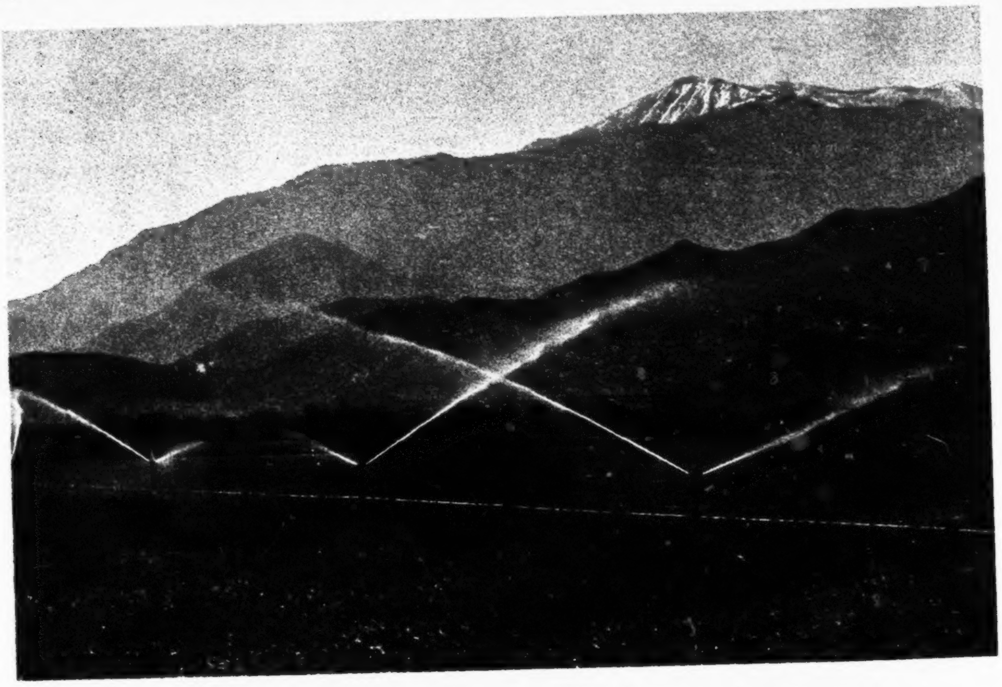


Figure 49.—Portable irrigation system under booster pump pressure.

Preparation for the Teacher

Technical assistance and information pertaining to the development of an irrigation program is available from the Soil Conservation Service in most communities where departments of vocational agriculture are located. Other sources of assistance include Land-Grant Colleges, Federal Extension Service, Experiment Stations, State Departments of Agriculture, irrigation company staff members, and commercial concerns that are interested in the development of irrigation systems or water conservation projects. Many of these sources of assistance also have reference material suitable for instructional purposes. The information provided herein for profile and differential leveling also applies to this activity.

Presentation by the Teacher

Plan, discuss, and demonstrate the several activities pertaining to irrigation after which have the students perform these on farms as they apply locally. Provide appropriate tests.

Discussion Topics

1. What has brought about the expansion of irrigation in the United States?
2. Under what conditions would you use the different methods of irrigation?

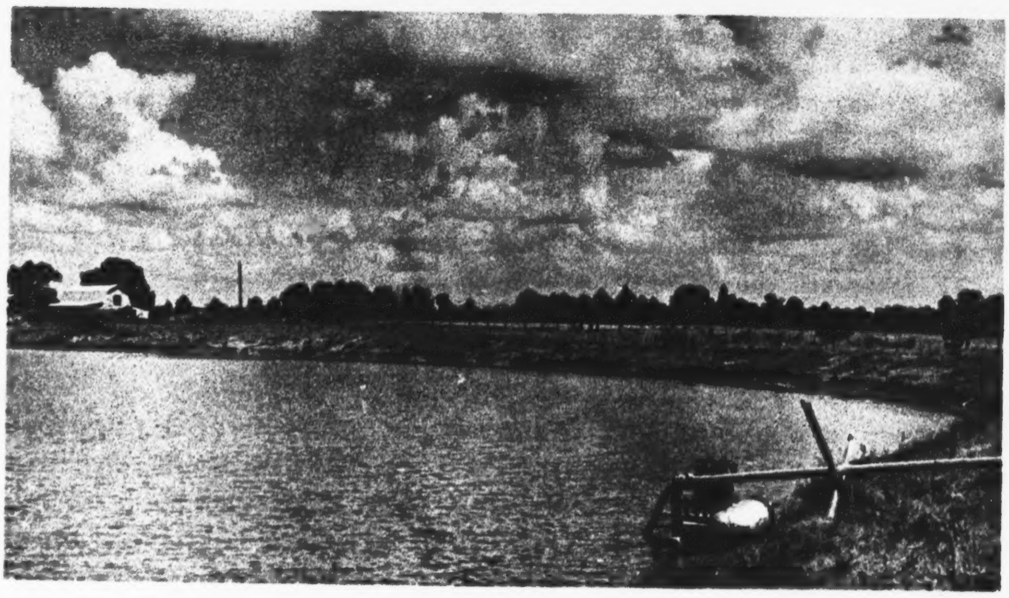


Figure 50.—A farm water storage reservoir used for irrigation, recreation, stock water, and fire control.

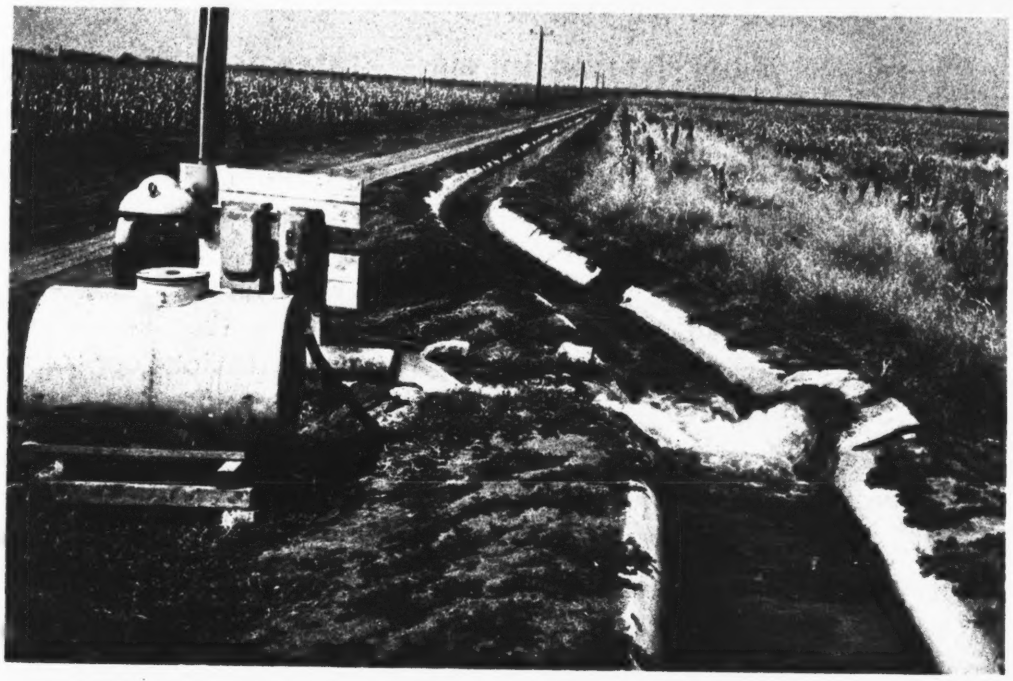


Figure 51.—Seepage loss was 10 percent per 1,000 feet prior to lining ditch.

3. What are the principal sources of water for irrigation?
4. How would you determine the efficiency of an irrigation pump?
5. What are the advantages and disadvantages of each kind of power used in pump irrigation?
6. What tools and equipment are necessary in constructing and maintaining an irrigation system?

7. What tools and equipment are needed for land leveling when preparing fields for irrigation?
8. What care and adjustment is essential to efficiently operate and maintain the equipment used in the irrigation program?
9. What factors affect length of runs and size of heads for the most effective use of water?
10. What are water rights and how do they protect the farmer?
11. What are the advantages of concrete lined irrigation ditches? Disadvantages?

Planning Farm Reservoirs and Water Storage

Water storage on the farm serves many useful purposes, such as those for irrigation, livestock, family needs, fire protection, recreation, and wildlife. (See Figs. 38, 39, and 50.) Storage facilities for water on the farm are relatively small when compared with those supplying irrigation districts. The size of water storage structures influences the specifications for construction.

Preparation for the Teacher

There are many sources in most States for information needed in the selection of water storage sites and the construction of dams, spillways, ponds and other physical features. These sources include Universities, State Colleges, Experiment Stations, Soil Conservation Service, A.S.C.S., State Irrigation Authority, and Water Planning Commissions. Some essential factors to consider when developing a water storage unit include—watershed, erosion control, adequate spillways, capacity of storage needed, seepage, sedimentation, construction material, location, and cost of development and maintenance.

Presentation by the Teacher

Plan, discuss, and demonstrate on a selected farm the activities relating to farm reservoirs and other methods of water storage. Have the students perform these tasks as they apply to the local farming situation and then provide appropriate tests.

Discussion Topics

1. What useful purposes are served by farm reservoirs and ponds?
2. What determines the size or capacity needs of a water storage system?
3. Where can you obtain technical information on the construction, maintenance, and use of farm reservoirs and other water storage systems?
4. Why is it necessary to protect against sedimentation? How performed?
5. How can seepage and other water losses be held to a minimum?

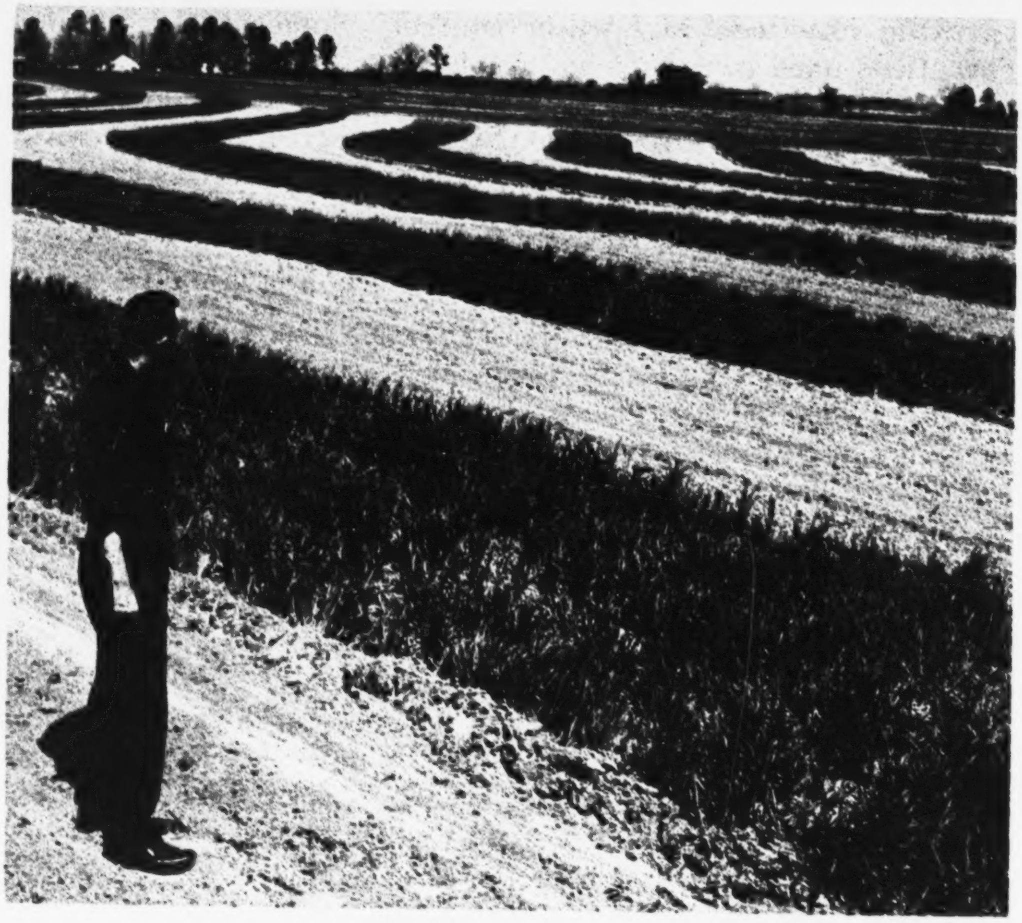


Figure 52.—A soil conservation technician surveys a wind and water erosion control program that was established on a 250-acre field.

6. What are the specifications of a good dam? Spillway?
7. What equipment is needed to construct and maintain water storage facilities?
8. How do you operate, maintain, and service water storage construction and maintenance equipment for efficient use?
9. What approval or authority is needed to construct water storage facilities? Inspection services?

Controlling Soil Erosion

The loss of soil through erosion by wind and water is of national importance. At the present time control is the dominant land-use problem on 57 percent of the Nation's cropland. It is a secondary problem on an additional 14 percent. The losses of soil have been offset somewhat through the increased use of commercial fertilizers, technological practices, and farm mechanization. Among the many factors involved with wind and water erosion of soil are slope of land, type of soil, prevailing winds, amount of rainfall, cultural practices, grazing practices, and water control. Some of the common practices used to reduce soil erosion include contour farming, terracing, strip cropping, deferred grazing, rotation grazing, vegetative cover, forestation, tree windbreaks, run-off water control, stubble mulching, and other tillage practices that help to control wind and water erosion.

Preparation for the Teacher

Sources of information and assistance listed under the previous job "Planning Farm Reservoirs and Water Storage" also apply to this job. Inservice and preservice training for teachers of vocational agriculture on needed skills and abilities should be available through the teacher-training department and from subject-matter specialists on the college staff. Other assistance is generally available through the State supervisory staff for vocational agriculture.

Presentation by the Teacher

Plan, discuss, and demonstrate on a selected farm or ranch the activities relating to soil erosion control. Have the students perform these activities as they relate to local situations after which provide appropriate tests.

Discussion Topics

1. How do you control soil erosion through such activities as the following: contour farming, stubble mulching, subsoiling, summer fallowing, terracing, sodding, and strip cropping?
2. In a soil erosion control program what land should be used for cultivation? Grazing? Forestry? Recreation?
3. How bring eroded land back into productive use?
4. What are some cultural practices to control wind and water in a soil erosion control program?
5. How does climate affect soil erosion?
6. What equipment is needed in a soil erosion control program? How operate, maintain, and service?
7. What is raindrop or splash erosion and how does it affect the soil?
8. How prepare the land to be receptive to the "dashing type" of rains and thus control erosion by water?
9. What are the different kinds of mulching? How practiced?
10. What is the responsibility of the farmer or rancher to follow those practices that reduce soil erosion?
11. What technical services are available to farmers or ranchers in a soil erosion program?

Chapter VI. Farm Buildings and Conveniences

PLANNING AND MAINTAINING FARM BUILDINGS

ON MOST FARMS the buildings represent approximately one-fourth of the total investment. Buildings comprise an essential unit in farm production, thus they must be designed for the most effective use. Building maintenance is ever present, therefore the farmer must be concerned with keeping the buildings in good repair. Lack of care of farm buildings will result in undue losses which is a serious factor that may influence the success of the farming business.

The average farmer will seldom construct more than one major building for a specific purpose or enterprise during his tenure. However, once constructed, the maintenance problem is continuous. The material used in construction and the care that follows determines to a large extent the expenditures for maintenance. This is evidence of the need for each farmer to plan and conduct a sound program to keep all buildings in a continuous serviceable condition. Refer to Chapter III for a listing of many objectives and suggested procedures under Farm Buildings and Conveniences.

Units of Instruction.—Buildings need to be designed specifically for the service they are to render in the farming program. Care must be taken that each building is functionally satisfactory. Most buildings are constructed for a specific purpose—as livestock, crops, farm machinery, poultry, and storage. For convenience some buildings provide a combination of services, such as those for livestock and storage.

Planning the Farmstead Layout.—The relationship between the buildings in the farm layout should be such as to assure the best use of time and labor often referred to as work simplification. The layout should incorporate essential features, such as—fire protection, location of feedlots, roadways, lanes, drainage, availability of water, safety, expansion needs, and relationship to the fields.

Construction.—The ever-present factor here is that the cost is commensurate to service rendered the business. The service and return rendered must satisfactorily amortize the cost if the expenditure is to be justified. Before starting construction of a building make certain that the plans are architecturally sound and suited for the purpose of the structure. Other factors of importance include location, size, drainage, relationship as an operating center to the farm layout and convenience. Many farmers have considerable construction materials available and can furnish much of the needed labor. Weather conditions permitting, it is well to plan farm construction during the period of less demand for labor in regular farm operations.

Reconstruction.—With the changeover on the farm from animal to mechanical power it became necessary to reconstruct many farm buildings. In most situations it was more economical to redesign the existing buildings than to construct new units for the service desired. In redesigning, or other reconstruction, pursue those precautions that will not weaken the structure with regard to stresses and strains to which the building may be subjected.

Maintenance of a Roof

This job involves many activities, such as repairing a leaky roof; deck treatment for re-roofing; application of shingles; nailing; and the covering of hips, valleys, and ridges.

Preparation for the Teacher

The teacher of vocational agriculture must be thoroughly familiar with all phases of each activity in the maintenance of a roof. This familiarity is gained through technical training, practical experience, and the careful study of appropriate references. Roofing is available in such materials as wood shingles, composition shingles, asbestos cement shingles, aluminum sheets, galvanized sheets, roll roofing, plastic products, and built-up roofing.

Detailed information on roof maintenance is available from the manufacturers and distributors of these roofing materials.

There are associations for many of these different roofing products, and the technicians on the staffs for some of these groups have prepared instructional aids in the use of their products. Such aids may be of assistance to many teachers of vocational agriculture in their farm mechanics program as it relates to roof maintenance.

Farm buildings from a construction standpoint fall into two categories; they are either portable or permanent. Portable buildings because of the handling in moving may have a greater maintenance cost than those of a permanent nature. In giving instruction in the farm building area, only one type of activity should be taught at a time. Select and teach each job pertaining to farm buildings or other structures and carry it through to completion by demonstration, participating experience, and a discussion period to be sure that the students can perform the job satisfactorily.

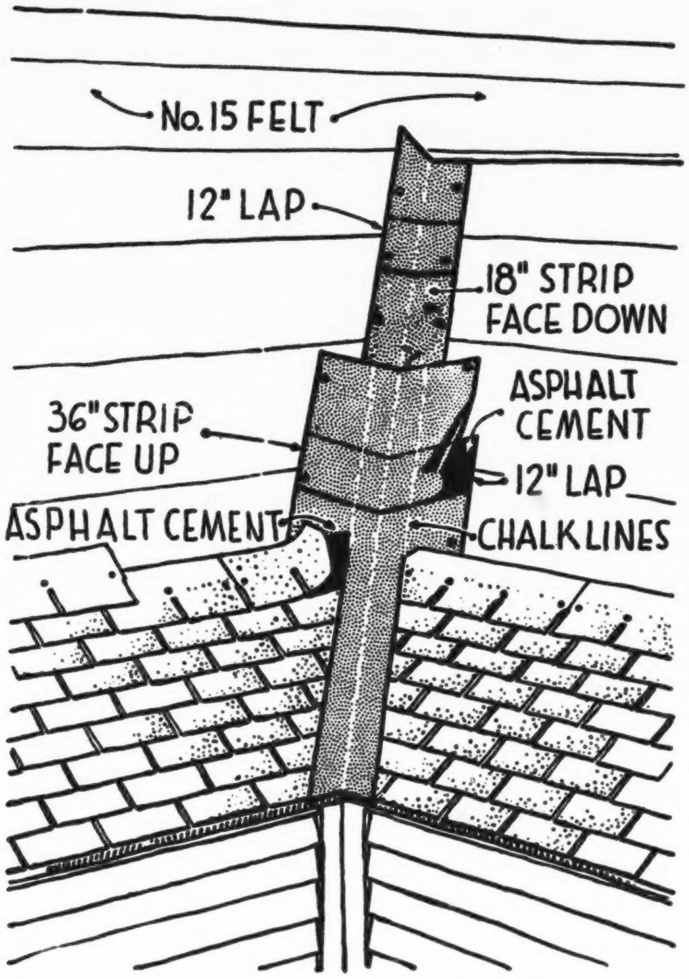
Presentation by the Teacher

Select a farm building for a roof maintenance demonstration that is not too far from the school. Secure the cooperation of the farmer. All of the materials, supplies, and equipment should be selected cooperatively by the teacher, farmer, and class, and must be delivered to the job before work begins. Each student should understand what is to be done. A demonstration for each phase of the job should be given before the students begin work. If a good job of instruction is to be done, not more than 15 students should be in the class.

Carefully supervise the participating experiences of the student. Instruct the students how to correct mistakes that may have occurred. Keep the class working as a coordinated unit and do not let a group get ahead or behind in the work.

A discussion period is essential after the participating experience is completed. It insures that the students understand each step of the job as well as why it was done in a particular manner. Workbooks will aid the students to master the job. The teacher should have on hand several discussion topics as well as answers to questions that the students may raise.

Some of the instructional topics presented in the maintenance phase of farm buildings are repairing a leaky roof, deck treatment for re-roofing, application of strip shingles, nailing, and covering hips and ridges.



Replacing a valley on a leaky roof.

Figure 53.—Use of roll roofing for typical open valley flashing.

Repairing a Leaky Roof.—A leaky roof may be caused in several different ways: shingles may have blown off, a valley flashing may have become loose or worn, a ridge board may have rotted out, a piece of metal roofing may have blown loose, metal roofing may have rusted through, or a sharp object may have made a hole in the roof.

When repairing a roof valley, have the material and tools on hand necessary to do the job. Show the students how to remove the nails from the shingles and flashing. If the shingles next to the valley are worn, it may be necessary to remove them back far enough to allow a new roll roof flashing 36 inches wide. Using a shear, cut a piece of roll roofing 18 inches wide and the length of the valley. Show how to center the 18-inch strip of roll roofing in the valley, bottom up and the

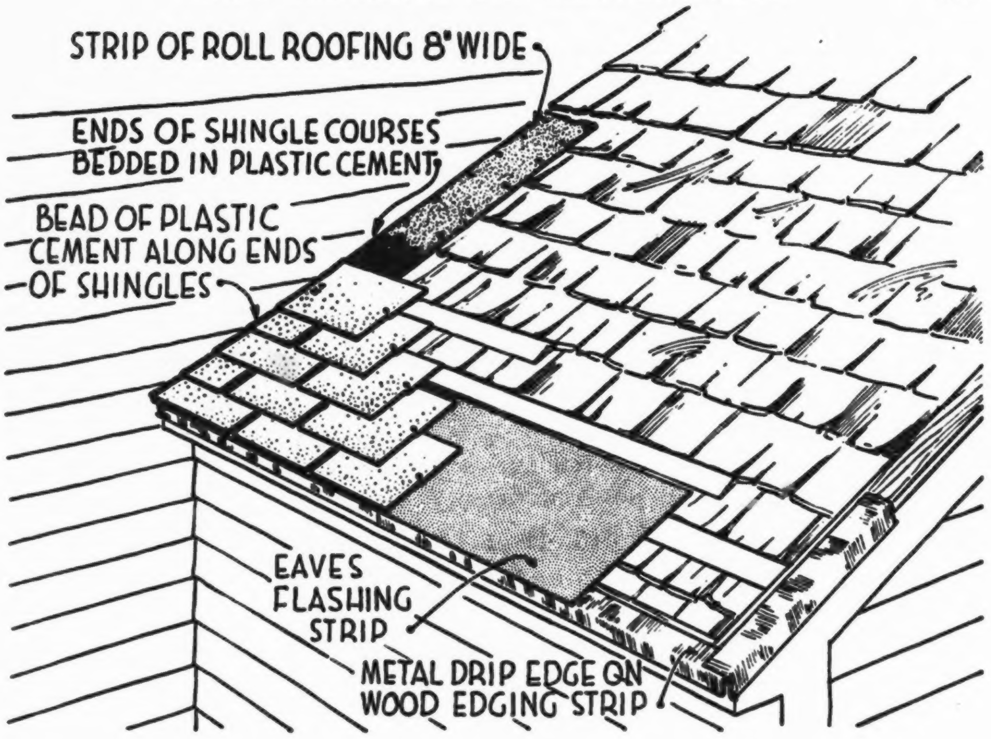

STRIP OF ROLL ROOFING 8" WIDE
ENDS OF SHINGLE COURSES BEDDED IN PLASTIC CEMENT
BEAD OF PLASTIC CEMENT ALONG ENDS OF SHINGLES
EAVES FLASHING STRIP
METAL DRIP EDGE ON WOOD EDGING STRIP

Figure 54.—Applying asphalt strip shingles over wood shingles.

lower edge cut flush with the eaves. When it is necessary to splice the material, the ends are lapped at the joint and secured with asphalt plastic cement applied to the felt between the upper and lower pieces. Only enough nails should be applied in rows 1 inch from each edge to hold the strip smoothly in place. As nailing along the second side proceeds, the roofing is pressed firmly into the valley. Show how to apply a band of asphalt plastic cement, 3 inches wide along each edge of the 18-inch strip after it is nailed, covering all nail heads. On top of the first strip of roll roofing, another strip 36 inches wide is placed, surface side up, centered and nailed as above except nails are placed in rows 2 inches from the edges of the strip. As the second row of nails is placed, the strip is pressed firmly down against the cement on the underlying strip.

Before replacing the shingles, 2 chalk lines are snapped the full length of the valley, one on each side, so that they will be 6 inches apart at the ridge (3 inches measured from the center of the valley along each of the intersecting roofs) and will diverge at the rate of 1/8-inch per foot as they approach the eaves. A valley 8 feet long will be 7 inches wide at the eaves. When the shingles are replaced, cut them to the chalk line to insure a clear straight edge. Before nailing the shingles to the roll roofing on the valley, apply a coat of asphalt cement to the flashing.

Deck Treatment for Re-roofing.—When a re-roofing job is under consideration a choice must be made between removing the old roofing or leaving it as it is. Generally it is not necessary to remove old shingles of wood, asphalt, or roll roofing before applying a new asphalt roof, provided a thorough inspection by a competent workman indicates that:

1. The strength of the existing deck and framing is adequate to support the weight of workers and additional new roofing as well as the usual snow and wind loads.
2. The existing deck is sound and will provide anchorage for the nails used in applying the new roofing.

If an inspection reveals that the old wood shingle roofing is suitable to remain in place under the new roofing, proceed by:

1. Removing all loose or protruding nails, and renailing in a new deck location.
2. Nailing down all loose shingles.
3. Splitting all badly curled or warped shingles and nailing down the segments.
4. Replacing missing shingles.
5. Cutting back the shingles at the eaves and outer edges of the roof far enough to allow the application at these points of a 1-inch board, 4 inches to 6 inches wide. Nail the board strips firmly in place, allowing their outside edges to project beyond the edges of the deck the same distance as did the wood shingles.
6. Preparing a smooth deck to receive asphalt roofing by using a "backer board" applied over the wood shingles or wood "feathering strips" along the butts of each course of old shingles.

If old asphalt shingles are to remain in place, nail down or cut away loose, curled, or lifted shingles and remove loose and protruding nails. Remove badly worn edging strips and replace with new ones. Before applying the new roofing, sweep the surface clean of all loose debris.

When new asphalt roofing is to be laid over old roll roofing without removing the latter, proceed as follows:

1. Slit all bulged or buckled areas and nail segments down smoothly.
2. Remove all loose and protruding nails.
3. Examine the exposed deck to note any loose or pitchy knots and excessively resinous areas. Cover such defects with sheet-metal patches from galvanized iron, painted tin, zinc, or copper, having a thickness approximately equal to 26-gage.

Remove the old roofing when the framing supporting the existing deck is not strong enough to support the additional weight of workers and new roofing during application, or when the old decking material will not furnish adequate anchorage for the new roofing nails. Under these conditions the old roofing, regardless of type, must be removed before applying the new roofing. The deck should then be prepared for the new roofing as follows:

1. Make repairs to the existing roof framing where required to level and true it up and to provide adequate strength.
2. Remove all rotted or warped sheathing and replace with new sheathing.
3. Fill in all spaces between boards with wood strips of the same thickness as the old deck and nail securely; or move existing sheathing together and sheath remainder of the deck.
4. Pull out protruding nails and renail sheathing firmly at new nail locations.
5. Cover large cracks, slivers, knot holes, loose knots, pitchy knots and excessively resinous areas with sheet metal securely nailed to the sheathing.
6. Just before applying the new roofing, sweep the deck clean of all loose debris.

Demonstrate the correct method of re-roofing a deck by applying such coverings as strip shingles, metal roofing, asbestos cement shingles, and roll roofing. Correct methods of laying each of the roof coverings may be obtained from manufacturers and dealers.

Application of Strip Shingles.—Demonstrate the laying of a galvanized steel or other corrosion-resistant 26-gage sheet metal strip along the eaves and edges of the roof over the felt. Show how to secure the strips with suitable roofing nails spaced 8 to 10 inches apart along its inner edge. Bend it down even with the edge of the roof and eave line.

Apply an eave flashing strip of 90 pounds mineral surface or 65 pounds smooth roll roofing to overhang the lower edge of the eave from 1/2 to 3/8 of an inch. Extend the flashing up the roof far enough to cover a point at least 12 inches inside the wall line of the building, but not narrower than 36 inches.

Demonstrate the laying of a starter course of shingles with the tabs facing up the roof to cover the eave's flashing strip flush with its lower edge. Remove 3 inches from the end of starter course to insure that all of its cutouts will be covered by the first regular course of shingles. The starter and first regular course should be set flush with the edges of the roof.

The first course is started with a full-length strip. The second course is started with a strip from which a portion has been cut off, while succeeding courses start with full or cut shingles, depending upon the style of shingles being used and the method of application followed. Normal exposure of square butt strips is 5 inches to the weather. Explain that when they are being applied in windy locations it is good practice to reduce the exposure to 4 inches.

Nailing.—Show the students how to use galvanized roofing nails, having a large head, at least $^3/_8$ inch in diameter and a shank long enough to penetrate to the under surface of the roof deck. The number of nails required varies with the product being applied. Shingles laid in perfect alinement will avoid buckling. Start nailing at the shingle last applied and proceed to the opposite end. Drive the nail straight to avoid cutting the fabric of the shingle with the edge of the nail head. Explain the damage to the surface of the shingle when the nail head is driven too far.

Covering Hips and Ridges.—Demonstrate how to cover hips and ridges as follows: Bend each shingle lengthwise down the center in order to have equal exposure on each side of the hip or ridge. In cold weather, warm the shingle before bending. Begin at the top of a hip or the end of a ridge. Apply the shingles over the hip or ridge, exposing them 5 inches to the weather. Secure each shingle with one nail on each side, 5½ inches back from the exposed end and 1 inch from edge.

The teacher should secure application methods for other types of shingles from the manufacturers.

Application and Testing.—Following the demonstrations covering the several parts on roof maintenance listed under "Presentation by the Teacher" the students under supervision are to perform similar tasks on buildings in the local area. When such work has been completed, the students will be tested on the job as performed.

Discussion Topics

1. What is meant by functional planning?
2. Why is it advisable to follow a planned method of building maintenance?
3. What benefits accrue from having a planned farmstead layout?
4. What are the steps to follow in laying out the foundation of a farm building?
5. What are some problems involved in reconstructing a building?
6. What are the various kinds of roofing?
7. What factors enter into making a choice of roofing for a building?

8. How would you determine whether or not to place new shingles over old ones?
9. What may cause a building that has been used for some time to sag in the middle?
10. How are metal sheets fastened together on a roof?

Farm Conveniences

In most farm operations there are many conveniences that enhance the efficiency of the work to be done. These conveniences include watering devices, self-feeders, elevators, fences, loading chutes, feed augers, and gutter cleaners. When constructing or purchasing such conveniences be certain that they are adequate as to size and durability; are suited for the job to be done; that maintenance service is available; that safety features are included; and that they are functionally suitable and easy to operate.

Preparation for the Teacher

Manfacturers and distributors of the many farm conveniences listed here have prepared numerous instructional aids pertaining to their products. These aids cover such items as selection, installation, operation, service available, methods of maintenance, and minor repairs. It is essential for the teacher to seek such aids to supplement his practical experience and technical training.

Presentation by the Teacher

Plan, discuss, select, and demonstrate the construction, installation, and use of farm conveniences. Assist the students in the selection, construction, maintenance, and use of such conveniences as they apply to their home farms. Test the students on these activities.

Discussion Topics

1. What kinds of watering devices do you need on your farm?
2. How can you assure operation of water devices during freezing weather?
3. What health hazards may accrue through improper use of watering devices?
4. What are advantages and disadvantages of self-feeders for grain? Roughages? Minerals?

5. What are the most common causes of operating problems with self-feeders? How prevent?
6. How may wind and moisture affect the operation of self-feeders?
7. What are the different kinds of elevators used on the farm? Augers?
8. What factors would you consider when purchasing an elevator? Augers?
9. What precautions would you follow when installing an elevator?
10. What are the essential maintenance points to assure trouble-free operation of an elevator?

Chapter VII. Farm Electrification

WITH THE TURNING of a switch, the farmer who has developed and activated an electrification plan can milk his cows, cool the milk, pump water, process grain and roughage, operate elevators and conveyors, brood pigs and perform many other activities thereby lightening his work load and increasing his productivity.

If electrification is to be of maximum use to the farmer, the farmstead must be adequately wired. Many farmsteads were wired originally for light service. Since that time such items as welders, milking equipment, brooders, refrigeration equipment, washing machines, and cooking equipment have been added.

The farmer is seldom a journeyman electrician, and is generally too busy with other work to be done. Codes for electrical installations are rapidly including the rural areas. The farmer, however, is interested in getting the farmstead adequately wired so that it will meet present and future needs.

Refer to Chapter III for a listing of objectives and suggested procedures under Farm Electrification.

PLANNING AND MAINTAINING WIRING SYSTEMS

Since the wiring systems on many farms were installed prior to the advent of numerous labor-saving electrical devices now in operation on these farms, the development and installation of a new wiring plan is a necessity in order to meet present and future needs as well as code requirements. Maintenance of any wiring system is an ever-present responsibility of the farmer, especially in his observance of safety practices.

Preparation for the Teacher

The teacher of vocational agriculture must be sufficiently skilled in farm electrification jobs to provide and demonstrate essential training in such jobs to his students. This skill and

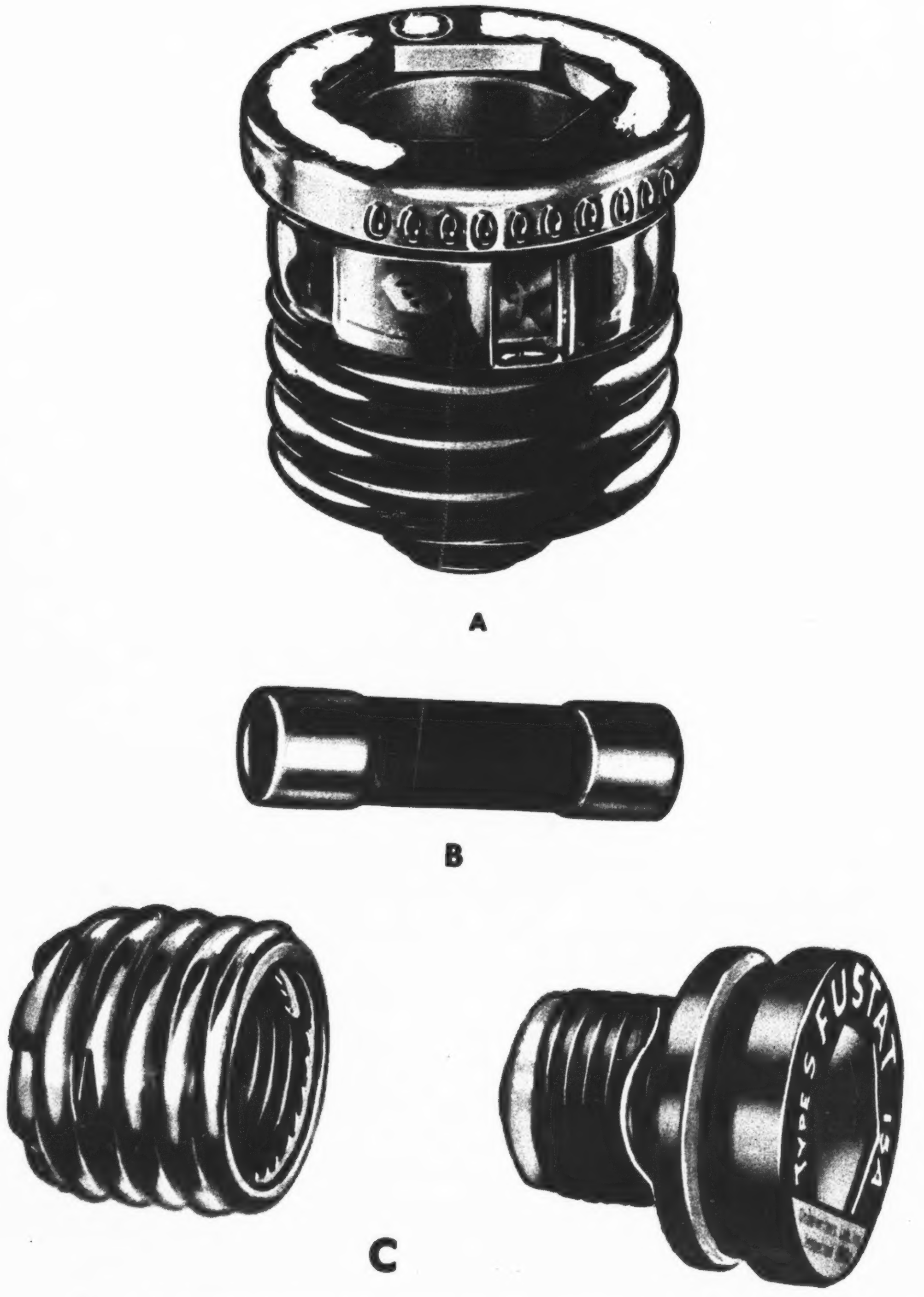

A
B
C
TYPE S FUSTAT 15A

Figure 55.—Kinds of fuses (A) screw type, (B) cartridge, and (C) fustat.

ability should be gained through technical training on a preservice and inservice basis, practical experience, teacher workshops, and by study. Other essential information and training aids in planning and maintaining wiring systems are available from suppliers of electric power and the manufacturers and distributors of electrical equipment.

Presentation by the Teacher

Instruction and demonstrations in farm electrification can be given in existing buildings on planning and maintaining wiring systems. Good and bad practices can be shown. Wiring plans can be made after explanations and demonstrations have taken place on the electrical wiring of farm buildings. Utilize the technical services available from the REA, Electrical Institutes, Power Suppliers, and the manufacturers of electrical equipment.

Select a farmstead that has an inadequate electrical system and one that has an adequate system. Using the electrical systems on these two farms, show the students the proper place to locate a distribution pole. Explain to the class the height of the pole needed.

Check size of wire and kind of insulation used on entrance wires on these 2 farmsteads to determine if they are satisfactory. Cooperate with the farmers so that they will also know your findings.

While working with the students, compute how many watts are on a circuit, and explain the maximum load of watts a circuit could carry safely. Check the kind of conduit used and the type and size of wire used inside the building.

Point out the several places that an electric light switch may be installed. Turn on all the lights and appliances on a circuit to find if the wires become heated. Also check the size of fuses to determine the protection they afford. Explain to the class that a light switch should not be located near the telephone, shower, or a wet place on the floor.

The following is a step by step procedure for replacing a single pole toggle switch. A single pole switch is used when a light is turned on or off from only one place.

1. Remove the fuse for the circuit in which the switch is being replaced or trip the circuit breaker. Using a test lamp determine that the circuit is not active.
2. Disconnect the wires attached to the switch. The white is the neutral wire, and the black is the hot wire. Install the switch to break the circuit on the black wire.

3. Clean the exposed ends of both wires by scraping. Then form an eye in both wires making certain that the eye in each is bent in the direction that the attaching screws turn for tightening.
4. Replace both wires to the new toggle switch terminals and tighten the screws for each.
5. Replace the switch in the box and secure it into position.
6. Replace cover and attach with screws.
7. Replace fuse to re-establish service to the circuit.

Application.—After the demonstration in farm electrification the teacher and individual students should survey the electrical systems on other farms. Aid the students in planning and maintaining adequate wiring systems in their home farm buildings.

Testing.—When the students have completed planning and maintenance activities on the home or other farm electrical system appropriate tests are to be given.

Discussion Topics

1. What safety precautions should be considered and followed when planning and maintaining a wiring system?
2. What are the advantages and disadvantages of a mercury switch?
3. What is the difference in wiring a single pole switch and a 3-way (often called a 2-way) switch?
4. Why do many convenience outlets provide for 3-pronged plugs?
5. What factors should be considered when locating convenience outlets?
6. What are the differences between a screw-type fuse, cartridge fuse, and a fustat?
7. Why are farmsteads supplied electrical energy with a 3-wire system?
8. What is the difference in wiring for 115 and 230 volts?
9. Define volt. Ampere. Watt. Kilowatt. Ground.
10. What is the safe wattage on each circuit for the electrical system in your home?
11. Where do you use the different kinds of conduit, such as rigid? Flexible? Metallic? Non-metallic?
12. What factors affect the size of wire to use in your electrical system?
13. Where can the local codes on electrical systems be obtained?
14. What provision is made for inspecting wiring systems?

Selecting, Maintaining, and Installing Electrical Equipment and Appliances

A business-like approach should be followed in the selection of electrical equipment to be used on each farmstead. To realize the greatest savings, convenience, and satisfaction from electrical equipment, it is imperative to understand appliance terminology and ratings, as well as to be fully aware of the varied applications of electric power. For efficient farm and home operation it is necessary to make the proper selection of electrical equipment. Such equipment must be economically advantageous, and provide maximum returns in labor savings, pleasure, and convenience as a part of farm and home operation.

Preparation for the Teacher

In the selection, maintenance, and installation of electrical equipment and appliances seek the advice and counsel of State universities, experiment stations, REA technicians, electrical associations and institutes, and those farmers who have had experience in the use of such items. Prior to investing in electrical equipment and appliances make certain that sufficient electrical energy is available and that the wiring is designed for and capable of handling the load. A separate circuit is necessary for many different installations in order to adequately protect the added service and also insure safety. By all means, have the wiring and installations inspected before the system is energized and the equipment put into operation.

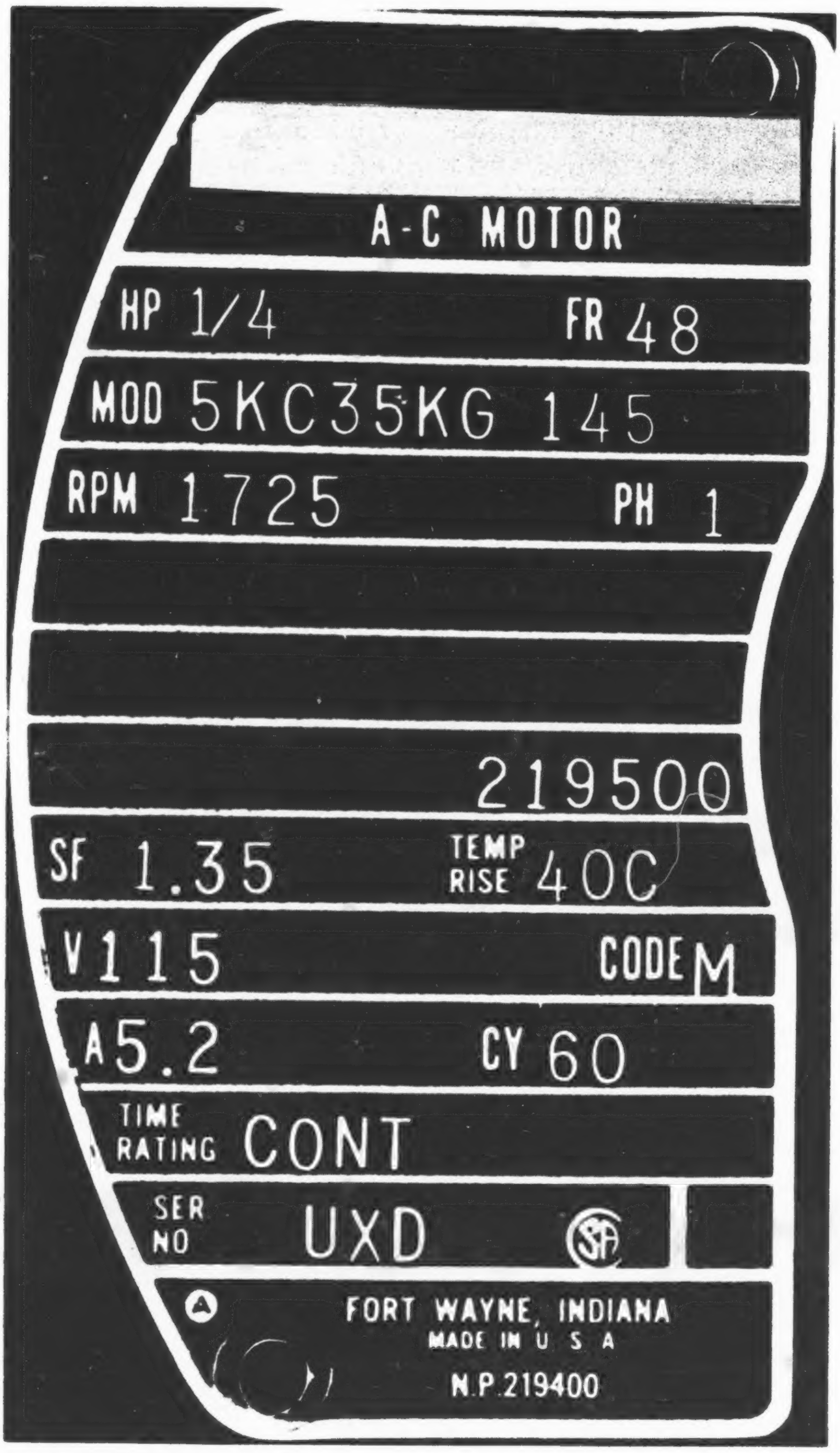
The National Board of Fire Underwriters tests all standard materials, appliances, and equipment used in electrical installations. All of these items, that pass laboratory tests, are included in a list of approved items and are permitted to be so labeled. The list of approved items may be obtained from the National Board of Fire Underwriters, Chicago, Ill. Certain seals and symbols applied to this electrical merchandise have meaning to the purchaser. These seals include those by Underwriters Laboratories, Inc. (UL) and *Good Housekeeping*.

The National Fire Protection Association publishes a book of instructions known as the *National Electric Code* for the protection and ultimate benefit of the farmer. Many States and cities also have codes.

Presentation by the Teacher

In order to train students in the proper selection of electrical equipment and appliances have such materials on hand for class work. Demonstrate the method of cleaning electric motors by first removing the motor bell housings and then the rotors. Show how to inspect and replace bearings. Explain the lubricating system and show how ball bearings require a different type of lubricant than that used for sleeve bearings.

1. Demonstrate how to repair electrical equipment, such as replacing a plug on an electrical cord, installing a new light switch, and repairing a small electrical appliance.



A-C MOTOR

HP 1/4 FR 48

MOD 5KC35KG 145

RPM 1725 PH 1

219500

SF 1.35 TEMP RISE 40C

V 115 CODE M

A 5.2 CY 60

TIME RATING CONT

SER NO UXD

FORT WAYNE, INDIANA
MADE IN U S A
N.P. 219400

Figure 56.—Electric motor nameplate.

2. Show how to fuse an electrical circuit. Explain that too light a fuse will cause interruption of electrical service and that too heavy a fuse will give little protection to the electric line and appliance used.
3. Have on hand the several kinds of conduits and wires to show the students the good and undesirable types for use inside the building.
4. Show the students how to hook up an electric motor. Explain why protective devices are used to keep electrical motors from burning out.
5. In the farm mechanics shop provide bench space and equipment for maintaining motors and small appliances.

Application.—Following the presentation by the teacher have the students participate sufficiently in job of selecting, maintaining, and installing electrical equipment and appliances in farm electrification (1) to become familiar with sources of information and assistance available for intelligent selection of electrical equipment, (2) to determine electrical equipment that could be advantageously used on the home farm, and (3) to understand the meaning of terms given on the nameplate of electrical equipment. When such tasks have been completed test the students on the work performed.

Discussion Topics

1. Why is it an unsafe practice to place a coin or tin foil behind a fuse?
2. How can you tell the size or amperage of a fuse to use?
3. When installing equipment what precautions should be taken in alining driven and drive units?
4. If upon inspection it is noted that the wires are heating how would you correct the problem?
5. How can you determine that the farmstead is adequately wired?
6. What device is available for the protection of an electric motor?
7. What is underground cable and why is it used for outside lighting? Kinds of underground cable?
8. How would you make an electric motor portable?
9. What is the purpose of a nameplate on an electric motor? Nameplate on an appliance? What information is given on a nameplate?
10. What is the purpose of grounding electrical equipment? How accomplished?
11. What steps would you take in selecting an electric motor for light service? Heavy service?
12. How are electric motors classified as to kinds? How do such motors differ?
13. Why is it necessary to have different kinds of starting devices for electric motors?
14. What maintenance requirements should be made on electric motors?
15. What are the common electrical symbols and their meaning?
16. What methods should be followed when making electrical connections?

Chapter VIII. Farm Shop Work

SKILLS LEARNED in the farm shop area constitute the foundation upon which much of the entire farm mechanics program can be built.

In order to economize on equipment and on the number of tools, more than one skill may be taught at a time in the shop. Farm shop work must be well planned to be effective. There should be class, group, and individual instruction accompanied by appropriate demonstrations. Individual participating experiences in the farm shop work area should be provided as soon as possible after each demonstration.

Whenever possible, students should work on farm shop jobs coming from their home farms and related to their own individual farming programs. Some skills will need to be perfected before they are used on actual jobs.

The teacher should follow up each demonstration to help students avoid mistakes and assist them in correcting any that may have occurred either in the farm shop at school or at the home farm.

Some skills in farm shop work may need to be eliminated or de-emphasized, such as rope, leather, and forge work, as well as saw filing and the making of handles for farm tools.

In the farm shop work area emphasis should be given to both maintenance projects and to new construction. Maintenance jobs may include the repairing of gates, home appliances, and feeding and watering equipment. New construction projects may include building hog self-feeders, bunk feeders for cattle, hay feeding racks, watering devices, poultry feeders, gates, and home conveniences. Larger construction items come under the area of Farm Buildings and Conveniences, Chapter VI.

Refer to Chapter III for a listing of objectives and suggested procedures under Farm Shop Work.

MAINTAINING FARM SHOP EQUIPMENT

The maintenance of shop equipment in proper working condition is an ever-present problem. Properly maintained tools are much safer to use and are essential for maximum production and quality workmanship. A quality control code should be rigidly adhered to in connection with all phases of the shop program. The job presented here will be the sharpening of a plane blade as a part of maintaining farm shop equipment.

Sharpening a Plane Blade

The servicing needs of a plane blade is typical of many other shop jobs in tool maintenance. Several of the principles involved with this job apply to other shop tools.

Preparation for the Teacher

The skill and ability needed by the teacher of vocational agriculture to demonstrate such jobs to his students should be gained through technical training on a preservice and inservice basis, through practical experience, and by study.

Presentation by the Teacher

As an example of maintenance for a shop tool, such as sharpening a plane blade, demonstrate the following steps:

1. Removing the blade clamp
2. Removing the blade
3. Removing the chip breaker screw
4. Removing the chip breaker
5. Replacing the chip breaker screw on the opposite side of the chip breaker
6. Turning the chip breaker over and replacing the screw—to allow the curved part of the chip breaker to be used as a guide when grinding the blade
7. Holding the plane blade at a right angle to the stone, grinding it until all nicks are removed. Check with a try square to determine if the edge is at a right angle to the body of the blade
8. Keeping the plane blade moving when grinding to eliminate any possible burns
9. Stopping the grinding process just before the plane blade becomes sharp

10. Using an oil stone to finish sharpening the plane blade by holding the heel and tip of the cutting bevel on the oil stone. Move the blade with a circular motion until a wire edge can be felt on the back of the blade. Remove the wire edge by turning the blade over so it is flat on the oil stone, and then pull it along the oil stone until no wire edge can be felt on that side. Continue on alternating sides of the blade until the wire edge is removed.
11. Reassembling the plane

Fitting and sharpening hand tools are important in the farm shop area. Demonstrate other skills in this area before students begin work.

Application.—Following the demonstration on sharpening a plane blade the students should perform this job in the school farm mechanics shop and at their home farm shops. Aid is given to the students through demonstration in performing similar jobs of sharpening other shop tools as a part of maintaining farm shop equipment.

Testing.--When the students have completed the job of sharpening a plane blade and other shop tools appropriate tests are given. Such tests help to determine the effectiveness of the training and serve as an aid in further improving the skills of the students.

Discussion Topics

1. Why are the corners of a plane blade rounded during the final whetting process?
2. How do you determine the width of plane blade bevel that should be maintained?
3. Why is it necessary to hollow grind the plane blade?
4. Why stop the plane blade grinding process before the blade is sharp?
5. When should a plane blade be replaced?
6. What care should be given the plane when in use?
7. How store the plane to avoid damage?
8. Why grind toward the tool edge rather than away from it?
9. How would you reassemble a plane after sharpening the blade?
10. Why have a planned program for the maintenance of farm shop equipment?

WORKING WITH HOT AND COLD METAL

The average farm has many jobs to be done that involve the use of hot and cold metals. The farm operator will need to have some understanding of the effect and use of heat on metals in the operation of his farm business. Oxyacetylene and the electric arc are common pieces of equipment on many farms that are used in heating, cutting, and welding metals. The machinery used on the farm has been largely fabricated by processes of welding thus necessitating the same procedure in the maintenance program on the farm. Both electric arc and oxyacetylene welding need to be taught with appropriate practice exercises before welding takes place on a piece of machinery. Although excellent welds may be made by the use of an oxyacetylene torch, it is more frequently used for cutting purposes.

Many maintenance jobs involve cold metal work. Some of the more common jobs with cold metals include—filing, bending, drilling, cutting, sawing, tapping, threading, reaming, punching, and riveting. Prepare for and present the cold metal jobs in a manner similar to that which follows for a job pertaining to hot metal.

Electric Arc Welding

The electric welding process has largely replaced the coal-burning forge because it is readily available and makes possible quick and strong repairs with a minimum of effort. Many of the welding jobs in the repair and servicing of farm machinery and the fabrication of metal in construction projects that was previously performed off the farm can now be readily done by the farmer. The use of the electric arc welder on the farm has proven to be economical and a time-saver in emergencies affecting farm operations.

Preparation for the Teacher

Through inservice and preservice training learn how to do the following tasks:

1. Set the amperage for an electric arc welder for various electrodes, metals, and thicknesses of metal.
2. Run practice beads on pieces of scrap metal.
3. Prepare two pieces of metal for welding.
4. Select the size and kind of electrode to use in welding different kinds and thicknesses of metal.

Make full use of printed material and workshops on arc welding that are available from manufacturers and distributors of welding equipment, electrical institutes, and technical schools.

3

Figure 57.—Father and son in home farm shop discuss safety procedures to follow in a maintenance program.

Presentation by the Teacher

Demonstrate how two pieces of 2-inch by 3-inch metal plate, ¼-inch thick, can be used for practicing butt welding. Butt the plates tightly together and weld, using beads 2 inches long. The student can break the weld after running the bead to examine it for penetration, slag inclusion, porosity, and density. Continue the welding practice by using the sides of the plates.

Show how two pieces of metal can be set up for making a fillet weld. In making this weld the electrode is used to fill in the joint. Break the joint after the weld has been made to determine the quality of work as was done in butt welding. The number of arc welders in the shop will determine the number of students who may practice at one time.

Application.—Have the students perform welding jobs using the electric arc. Continue this practice until they are sufficiently proficient to apply this training to actual construction and reconstruction activities involving hot metals.

Testing.—When the students have completed the assigned jobs of learning how to use hot metals, the work completed will serve as the basis for tests.

Discussion Topics

1. What safety practices need to be followed in doing hot metal work? Cold metal work?
2. What factors would you consider when buying an arc welder for your farm? Oxyacetylene equipment?
3. Should farm welding be equally as strong as that used for industrial purposes?
4. How determine if the weld has sufficient penetration?
5. In what positions must one be able to make welds?
6. What maintenance work is necessary on an arc welder?
7. How do you drill metal without damaging the bit?
8. What causes the thread to strip on a pipe or bolt when cutting them with a die?
9. At what speed do you operate a power hacksaw?
10. What method would you use when cutting pipe? Explain.

Glossary

SOME OF THE more commonly used terms in farm mechanics follow:

Acetylene—A fuel gas commonly used in oxyacetylene welding and cutting.

Additive—A product added to the oil to improve the performance of the engine. Detergents, antifoam agents, and oxidation inhibitors are additives.

Ammeter—An instrument for measuring electrical current.

Annealing—Softening of metal.

Bank-run Gravel—The natural mixture of sand and gravel as taken from a gravel bed. Such a mixture may lack uniformity.

Base Metal—Metal to be welded or cut, or one that is being processed by welding or cutting.

Blow-by—The escape of gases, fuel-air mixture, and moisture from compression going past the piston rings, piston, and cylinder wall.

Breaker Points—Points interrupting the electrical current in the primary winding of the coil that induces a high-voltage current in the secondary winding of the coil. The breaker points are timed with the engine so that the high-voltage current is delivered to the spark plugs at the proper time for the spark to jump between the electrode points of the spark plug to ignite the fuel-air mixture.

British Thermal Unit (B.t.u.)—One B.t.u. is substantially the heat required to raise 1 lb. of water 1° F. in temperature, as from 37° to 38°F.

Bronze Welding—A kind of oxyacetylene or carbon arc welding in which parts are joined by coating with bronze instead of by melting or fusion.

Butt Weld—Weld in joint between two pieces of metal lying in about the same plane.

Camshaft—A shaft with projections, known as cams, having a definite shape for imparting exactly timed movement to the valves of an engine.

Castellation—one part of a castle nut that is formed by radial grooves in its upper face to receive a cotter key passed through a hole in the bolt to prevent the nut from turning.

Circuit—The path of continuous flow of electric current, consisting usually of two wires, one to bring the current from the generator or other source of supply and the other to take it back.

Clutch—A device for connecting one shaft to another for the purpose of transmitting power smoothly, and for disconnecting the power unit from the driving members.

Condenser—A device that is connected across the breaker points to absorb the electrical current in the primary circuit at the time the points open, thus preventing arcing at the points and helping to build up a higher voltage in the secondary circuit.

Contour Farming—Farming in such a way that field operations, such as plowing, fitting, planting, cultivating, or harvesting, are done by following the contours of the land or by following terraces and strips on acceptable grades.

Contour Furrowing—Plowing furrows on the contour, usually on pasture or range land, to prevent soil loss and allow water to penetrate the soil. Sometimes used in planting trees or shrubs on the contour.

Contour Line—Level line across a slope. All points are on the same level.

Contour Stripcropping—A system of cropping sloping land by growing crops in strips planted on the contour or parallel to terraces or diversions. Usually strips of grass or close-growing crops are alternated with strips of clean-tilled crops.

Cranking Motor—An electric motor incorporating a gearing arrangement that has a small drive pinion or a bendix on the cranking-motor armature shaft which, in operation, meshes with gear teeth on the engine flywheel. The gear reduction, of about 12:1, permits the cranking-motor armature to turn at fairly high speeds so that it will develop greater power while cranking the engine at a rather low speed.

Crawler Tractor—A track-laying type of tractor.

Current-voltage Regulator—A device that provides control of the generator output and circuit voltage so as to meet various battery and operating requirements.

Cut Acid—Zinc chloride or the liquid produced by the action of muriatic acid on zinc. Used as a soldering flux.

Cutout Relay—A device that closes the circuit between the generator and the battery when the generator is operating at speed sufficient to charge the battery, and which opens this circuit, when the generator slows down or stops, to prevent the battery from discharging back through the generator.

Cylinder—The piston chamber in an engine.

Depth of Fusion—Distance fusion goes into base metal during welding.

Detergent—A substance having cleaning power added to an engine oil, keeping in suspension those products that often form deposits in an engine. A detergent oil keeps a clean engine clean and gradually removes deposits from a dirty engine.

Differential—A device for the application of equal force to each of two independent shafts, regardless of the speed at which each revolves in relation to the other.

Distributor—An apparatus for directing the secondary electrical current from the induction coil to the several spark plugs in their proper order of firing.

Electrode Holder—Device that holds electrode and conducts current to it.

Electrode Lead—Conductor between current source and electrode holder.

Electrolyte—A solution of sulfuric acid and water as used in storage batteries.

Erosion—The day-to-day or current removal of soils and soil materials from the land where they had been placed by soil-forming processes. Both surface and subsoil materials are subject to erosion.

Gully—The channels produced on slopes by water concentrated in depressions. These channels are too deep to be crossed by ordinary farm implements and are not filled by the usual methods of tillage.

Rill—A miniature gully that is easily obliterated or filled by ordinary seedbed preparation and cultivation. If left untouched, rills grow into gullies.

Sheet or Surface—The more or less uniform removal of soil from the surface of slopes. Rills that are filled by cultivation have the same final effect as sheet erosion.

Wave—The removal of sand and soils or soil materials by wave action on shorelines of oceans and lakes. The wearing away of bedrock shorelines might be considered as geological erosion because it is relatively slow.

Wind—The removal of soil and soil material by wind action. Medium-textured soils in the drier areas, sandy soils, sands, and organic soils in humid areas are most subject to injury by wind action.

Fillet Weld—Weld with triangular cross section joining two surfaces at about right angles to each other in a lap, tee, or corner joint.

Flux—A fusible material applied to metals when welding to reduce the formation of oxides, nitrides, and other undesirable inclusions as an aid in the fusion or adhesion of metals.

Fuse—Device in the electrical circuit to protect certain parts, such as the lights, by interrupting the circuit when the current increases beyond a safe limit.

Fusion—Melting together of base metal and filler metal, if any.

Generator—An electric machine that when turned at certain speeds will produce a flow of electrical current. The direct-current generator on farm tractors serves, among other things, to maintain the tractor storage battery in a charged condition or to recharge the battery by forcing electrical current back into the battery. This current, as it is forced through the battery, reverses the chemical actions so that the original chemicals reappear in the battery.

Governor—An attachment to an engine that automatically controls engine speed, usually by regulating the supply of fuel.

Grommet—An eyelet, often rubber insulated on a tractor, which holds in place electrical wires or other parts that pass through it.

Grousers—The lugs attached to tractor wheels and to track links to increase traction.

Horsepower—One horsepower is the rate of doing work equivalent to raising 33,000 lbs. against the force of gravity 1 ft. in 1 min., or to raising 550 lbs. 1 ft. in 1 sec. 1 hp=42.4 B.t.u. per min.

Horsepower, Belt—The horsepower of an engine that is available at the belt pulley for operating belt-driven machinery.

Horsepower, Brake—A measure of the power developed by an engine actually pulling against the load of a brake or dynamometer.

Horsepower, Drawbar—The horsepower of an engine available at the drawbar for pulling, like pulling a plow. This is less than the horsepower generated by the same engine on the belt because of friction introduced by the transmission and traction conditions.

Horsepower-hour—1 horsepower exerted continuously for 1 hour.

Hydrometer—A storage-battery hydrometer is a device that gives a reading showing the specific gravity of the electrolyte being tested. It indicates how much unused sulfuric acid remains in the electrolyte solution and is, therefore, a convenient measure of the approximate capacity still available in a storage-battery cell. No hydrometer reading is actually correct until a temperature correction has been applied.

Ignition Coil—A pulse transformer that steps up low battery or generator voltage to high voltage necessary to jump gaps at spark-plug electrodes in engine cylinders.

Kilowatt-hour—A measure of usage of electrical energy that represents one watt of electrical power for 1,000 hrs. or 1,000 watts for 1 hr.

Micrometer Caliper—An instrument to measure minute distances accurately.

Miles per hour (mph)—The miles traveled per hour. A rough way to estimate the speed of a tractor is to walk beside it for 20 secs., taking 36-in. steps, and count the number of steps taken. This number divided by 10 will give the approximate speed in miles per hour. For example, 30 steps in 20 secs. = 30/10 = 3 mph.

Ohm—The unit of electrical resistance representing the physical property of a conductor that offers a resistance to the flow of electricity, permitting just one ampere to flow at one volt of pressure.

Peening—Working metal with a hammer.

Penetration—Depth of fusion zone below surface of base metal.

Pigment—The finely divided particles of solid material in paint, such as white lead, zinc oxide, or titanium.

Piston—A cylindrical piece of metal that slides inside a cylinder that is moved by, or moved against, pressure.

Power—The capacity to convert energy to useful work. One horsepower equals 42.4 B.t.u. per min. Heat can be converted to energy and energy to heat; therefore, power is sometimes erroneously considered to be heat or energy. Friction is an example of energy converted into heat, and the burning of a fuel-air mixture in an engine is an example of heat converted into energy.

Revolutions per minute (*rpm*)—With a tractor, the number of times per minute that the crankshaft makes a complete revolution.

Spatter—Drops of molten metal and slag thrown out of weld metal and base metal by arc or gas pressure.

Specific Gravity—In reference to the electrolyte used in storage batteries, the weight of the electrolyte as compared to an equal volume of pure water when both liquids are at the same temperature.

Splined Shaft—Usually a number of equally spaced grooves cut in a shaft to form a series of keys that project and fit snugly into a grooved internal-cylindrical member.

Storage Battery—A "chemical factory" in which chemical actions produce a flow of electrical current when any electrical device is connected to the terminals of the battery.

Stroke—The movement of a piston from one end of a cylinder to the other.

Tachometer—An instrument that shows instantly the speed of a revolving shaft or pulley, whereas a speed indicator or "revolution counter" records the revolutions for a given period of time.

Temper–To bring to the desired degree of hardness, usually by heat-treatment and cooling of the metal.

Temperature Gage–A thermometer consisting of a bulb in the engine water jacket that is connected by a thin tube to the dial, where the temperature of the coolant is indicated. This device is often referred to as the heat indicator.

Thermostat–An automatic device to assist in maintaining desired engine temperature by opening and closing a valve or damper to control the flow of coolant in the cooling system. Thermostats utilize the differential expansion of solids, liquids, or gases subjected to heat for the control of the valve or damper.

Thickness Gage–Often referred to as a "feeler gage," usually a series of metal strips or wires of known thickness as marked. An instrument of precision to measure the distance between different parts, such as spark plug electrodes.

Tractive Efficiency–The mechanical efficiency with which a given tractor accomplishes a given job.

Universal Joint–A joint that makes it possible to transmit power from one shaft axially to another, though the shafts lie at varying angles to each other. They are often used in pairs connected by a slip joint to accommodate changes in distance between them.

Valve–A device in an engine by which the flow of gas may be started, stopped, or regulated by a movable part which opens or obstructs passage.

Vehicle–The liquid portion of a paint, usually oil, that serves as a carrier of the pigment or solid particles.

Viscosity–The resistance of an oil to flow, determined by timing the flow of a measured quantity of oil through a carefully calibrated opening under controlled temperature conditions.

Voltmeter–An instrument for measuring cell voltage or for measuring in volts the variations between different points on an electrical circuit. Connect voltmeter in parallel with the circuit of which the voltage is to be measured.

Watt–The unit expressing electrical power, equal to the volts (pressure) times the amperes (rate of flow). Thus 4 volts times 4 amperes would give in a direct current 16 watts.

Wind Stripcropping–Growing crops in strips at right angles to the general direction of prevailing winds without regard to the contour of the land. Usually strips of wind-resistant crops are alternated with other crops or fallow to prevent surface movement of soil over broad areas.

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